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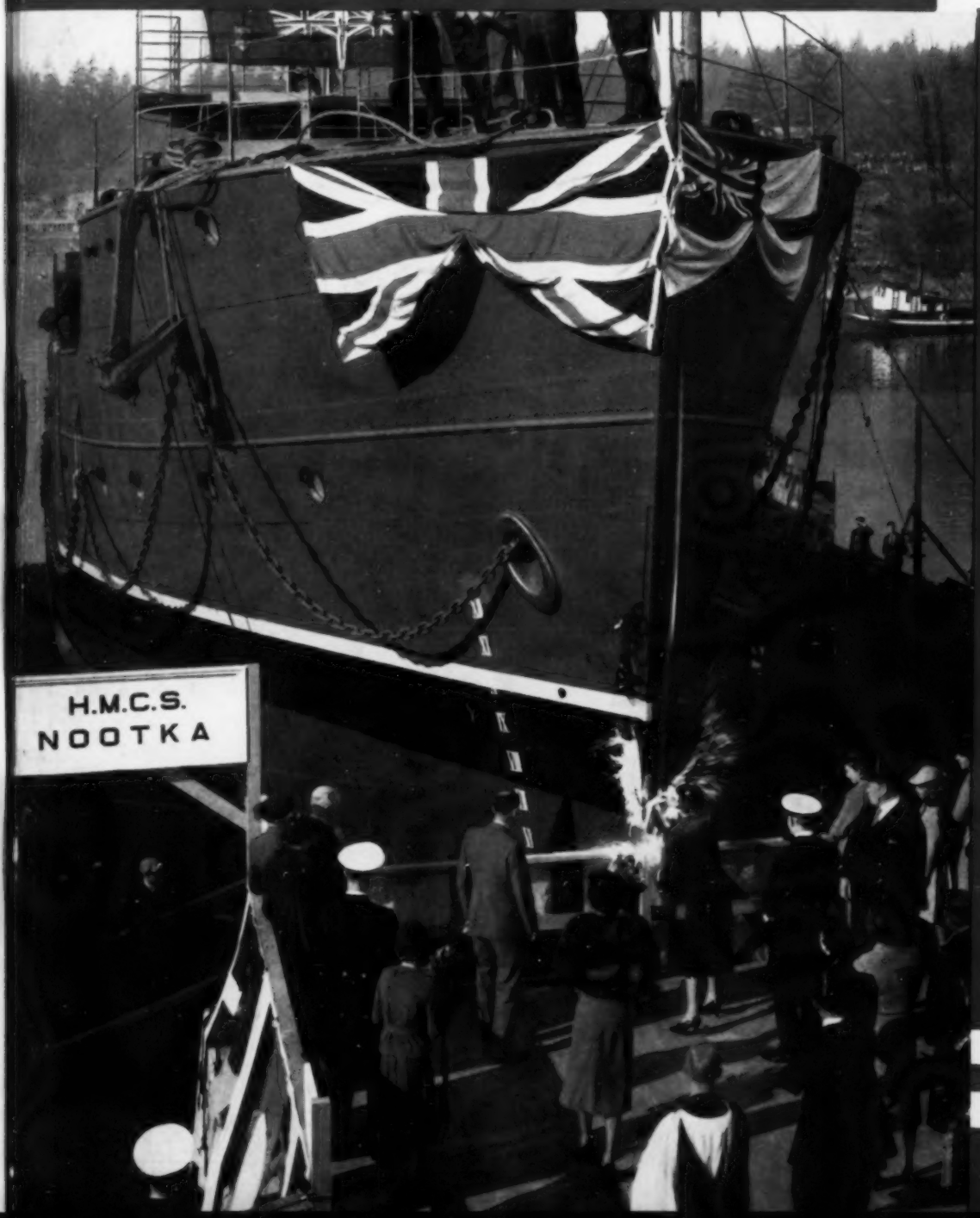

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The Canadian Geographical Society

OTTAWA, CANADA

The Society's ambition is to make itself a real force in advancing geographical knowledge, and in disseminating information on the geography, resources and peoples of Canada. In short, its aim is to make Canada better known to Canadians and to the rest of the world.

As one of its major activities in carrying out its purpose, the Society publishes a monthly magazine, the Canadian Geographical Journal, which is devoted to every phase of geography—historical, physical and economic—first of Canada, then of the British Empire and of the other parts of the world in which Canada has special interest. It is the intention to publish articles in this magazine that will be popular in character, easily read, well illustrated and educational to the young, as well as informative to the adult.

The Canadian Geographical Journal will be sent to each member of the Society in good standing. Membership in the Society is open to any one interested in geographical matters. The annual fee for membership is three dollars in Canada.

The Society has no political or other sectional associations, and is responsible only to its members. All money received is used in producing the Canadian Geographical Journal and in carrying on such other activities for the advancement of geographical knowledge as funds of the Society may permit.

CANADIAN GEOGRAPHICAL JOURNAL

Editor - *Gordon M. Dallyn*

172 WELLINGTON STREET, OTTAWA

This magazine is dedicated to the interpretation, in authentic and popular form, with extensive illustrations, of geography in its widest sense, first of Canada, then of the rest of the British Commonwealth, and other parts of the world in which Canada has special interest.

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COVER SUBJECT:—Launching in 1938 at one of British Columbia's shipyards of H.M.C.S. *Nootka* — 2,069 gross tons. Length 251.3′, breadth 43.9′, depth 20.3′. The H.M.C.S. *Nootka* exemplifies the minesweeper type, however, British Columbian as well as other Canadian yards have facilities for building large ocean-going vessels.

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The British standard of spelling is adopted substantially as used by the Dominion Government and taught in most Canadian schools, the precise authority being the Oxford Dictionary as edited in 1936.

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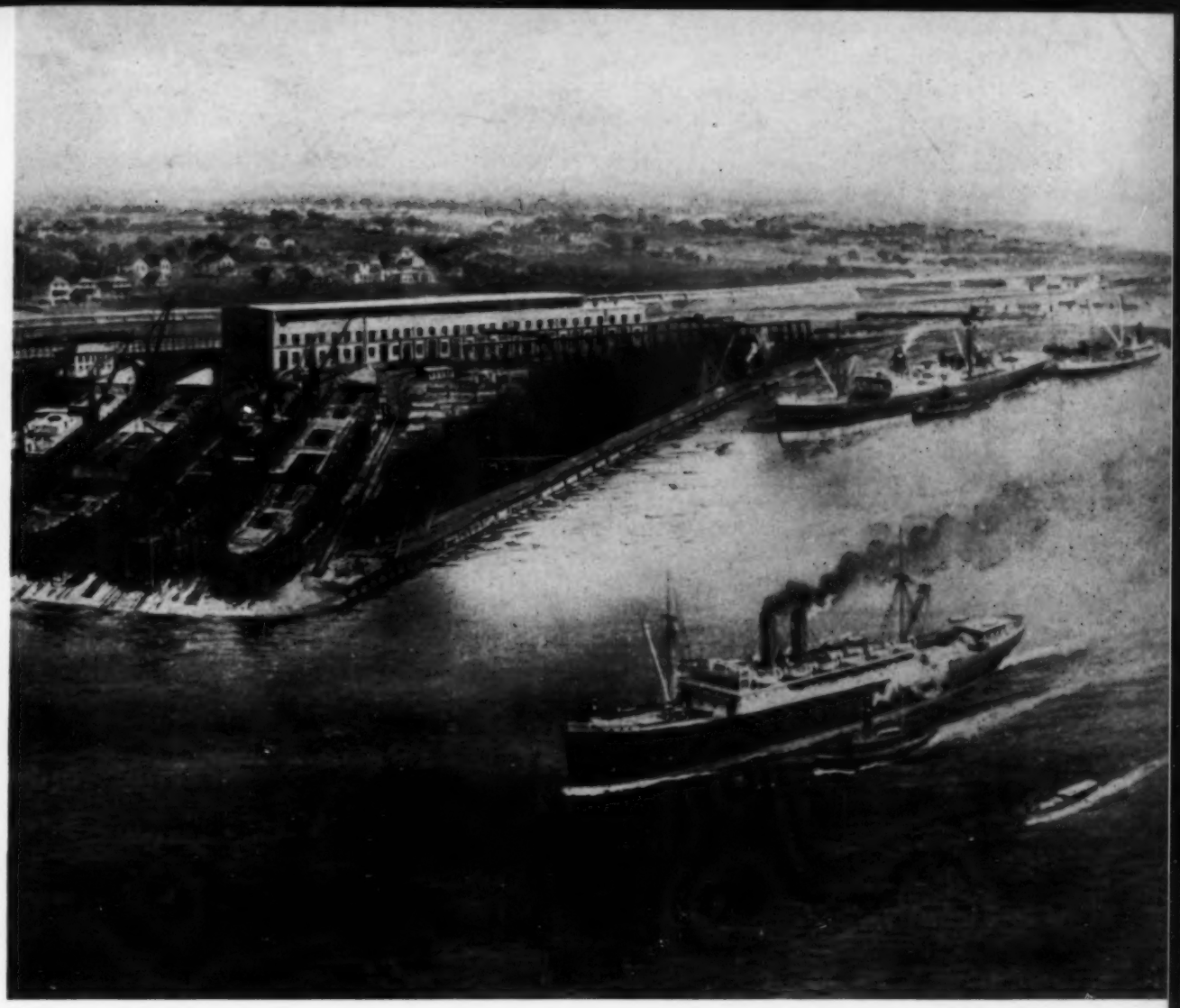
Canada possesses shipyards capable of building large ocean-going vessels of 8,000 tons. Larger vessels can be built

CANADA'S SHIPBUILDING INDUSTRY

by **WESTON GAUL**

FROM present indications, the shipbuilding industry in Canada is due to undergo considerable expansion during the current year; in fact, steps already taken more than substantiate this belief among shipbuilding firms in the Dominion. These firms, of which there are approximately forty, have had a difficult struggle for the most part to survive economic conditions in recent years; and while threats of war, coupled with expanded naval programmes, have caused a rapid increase in shipbuilding in all other countries since 1937, Canada has, so far, lagged behind in this expansion. This is due partly to greater relative labour costs; also to the fact that very few deep-sea shipping companies using Canadian ports are of Canadian capitalization. The tendency, therefore, has been to have their vessels, especially the larger cargo and passenger types, built in the United Kingdom.

To-day, with the country at war, the need for new ships is becoming more and more urgent, and there is very little doubt



on the Great Lakes, but the latter could not go through the canal locks. A typical view of an active Canadian shipyard.

that Canada is going to be called upon to play an important role in supplying certain types of ships; a role she played with commendable success in the Great War of 1914-18. As is well known, this war had a tremendous effect on the shipbuilding industry all across the Dominion. The years leading up to this period saw the industry in much the same state as characterized its fortunes in recent years. There was no great demand for the type of ships the Canadian shipyards could build, and apart from filling local contracts the majority of the yards found times very inactive; but with the outbreak of the Great War all this changed overnight. Canadian shipbuilding firms were given contracts to construct sixty-three steel cargo vessels of six different types, and fifty-seven of this number were actually completed, with a tonnage of 353,450 tons.

We can best appreciate the effect this increased activity had on the industry at that time by comparing figures of a pre-war year with those of a year during the War. Take, for example, the year 1910. The total value of production in Canada's shipbuilding industry that year stood at $5,136,257. In 1915 that figure had climbed to $7,780,501; in 1917, it stood at $35,281,350; in 1918, it had almost doubled again, at $74,799,411; and in 1919, when the industry had reached full capacity in its war effort the production figure stood at $86,489,713. To expand this comparison a bit further, whereas the year 1910 saw but a few ships being built in Canada's shipyards, the year 1918 saw fifteen war vessels built, fifty-four steel vessels, ninety-five wooden vessels, with eighty-two other vessels under construction, besides repairs to vessels and custom work amounting to

$8,038,164. That year saw ninety shipyards in the Dominion, an increase of forty-seven over the number existing in 1910.

Bearing this in mind, we can readily appreciate that the present conflict is going to have a very real effect upon the shipbuilding industry in Canada; in fact, already the Dominion Government has given out contracts to shipbuilding firms in the Dominion for the construction of a fleet of anti-submarine craft, and at the time of writing, it has under consideration the awarding of contracts for the construction of aircraft salvage vessels and minesweeping vessels as well, bringing this initial shipbuilding order to a figure totalling approximately $25,000,000. That this is not the whole shipbuilding programme contemplated is intimated by Hon. J. L. Ralston, Minister of Finance. In this connection, it has been announced that in all likelihood Canada will be asked to build a fleet of fast ships for the purpose of carrying grain, munitions and war supplies of every kind across the ocean to British ports. Perhaps as you read this article, this plan has been adopted. In any event, considerable impetus will have been given to the industry by that time, for there is no question about the ability of the Dominion to build ships for Britain's war needs: a quick survey of the industry's present-day facilities readily indicates this to be so. At the present time, shipyards at a dozen points in Canada, in the Maritimes, along the St. Lawrence waterway and on the Pacific, anticipating a branching out in operations, are busy preparing their equipment and personnel for increased production. All of these shipbuilding firms offer facilities by which shipbuilding could be readily stepped up to meet almost any demands in the way of cargo boats and other craft. At Sydney, Hamilton, Sault Ste. Marie and elsewhere are Canadian steel mills that could meet every demand of the shipbuilders, and many Canadian engineering firms are suitably equipped to supply engines and boilers, or even Diesel engines. One firm told the writer that many Canadian companies are capable of turning out steam engines and boilers for vessels up to 8,000 to 10,000 tons dead-weight, and that steel would not be difficult to obtain as there are large supplies in the mills of both Canada and the United States.

Steel, of course, is not the only material we must look for in order to gauge the capabilities of the industry to expand at a rapid pace and meet the requirements which may be demanded of it in the next few years. Besides steel, we have iron, wire, and other non-ferrous metals such as brass and bronze, aluminum, copper, lead, tin, zinc; electrical supplies such as electric motors and generators; lumber, cordage, cables; paints, oils and varnishes; and upholstering materials and plumbing supplies; but the fundamental contributing factor and one of chief importance in all shipbuilding is a trained personnel.

And we are fortunate in Canada to-day that the shipbuilding industry possesses this factor in the highest degree. The standard of workmanship in Canada's shipyards is high, and structural steel workers of the best type are available. In the Maritime Provinces, particularly in Nova Scotia, where the wooden shipbuilding industry still survives, and along the lower St. Lawrence, many skilled artisans are available; while on the Great Lakes, (where Canada's iron and steel

Left—Interior of an engine room.

Right—One of Canada's harbours on the Great Lakes.

vessels ply the grain traffic of the West), as well as on the Pacific Coast, there are to be found many shipbuilding men of high efficiency. Many of our skilled workmen were trained in the United Kingdom and are at present or have been employed in shipbuilding, ship repairing or allied industries.

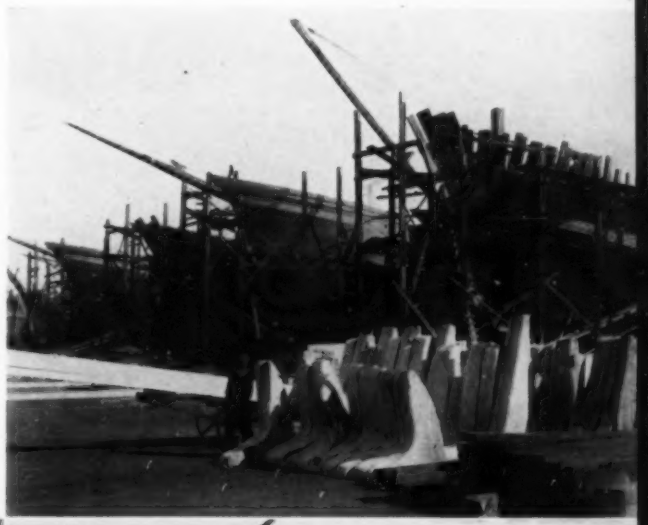
The statisticians provide the latest available figures:—"Forty shipyards were in operation in 1937, there being sixteen in British Columbia, eight in Nova Scotia, eight in Ontario, six in Quebec, one in New Brunswick, and one in Manitoba. Capital employed in these works amounted to $29,163,717, employees numbered 3,502, salaries and wages totalled $4,411,910, fuel and electricity cost $279,993, and materials cost $3,204,905. Twenty-five of the shipyards were occupied entirely with repairs in 1937.

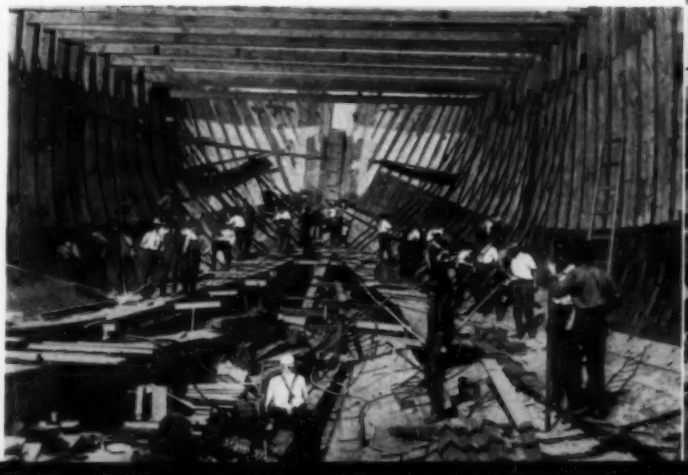
"The value of work done in shipyards in Canada during 1937 amounted to $10,360,686 compared with $6,205,127 in 1936 and $7,124,474 in 1935. The 1937 total included $825,433 for work done on new vessels completed during the year, $780,572 for work done on unfinished vessels, $6,125,304 for ship repairs, and $2,629,377 for other products such as aircraft, industrial machinery, fabricated structural steel work, etc. Only thirty-six new vessels were launched during 1937 and the finished value of these ships was $1,030,392, including the value of work done on them in the previous year."

From the standpoint of year-round employment it is of particular interest to note that in the year 1937, under review, the average monthly record of wage earners was 3,083, the lowest monthly record being that of January with 2,784.

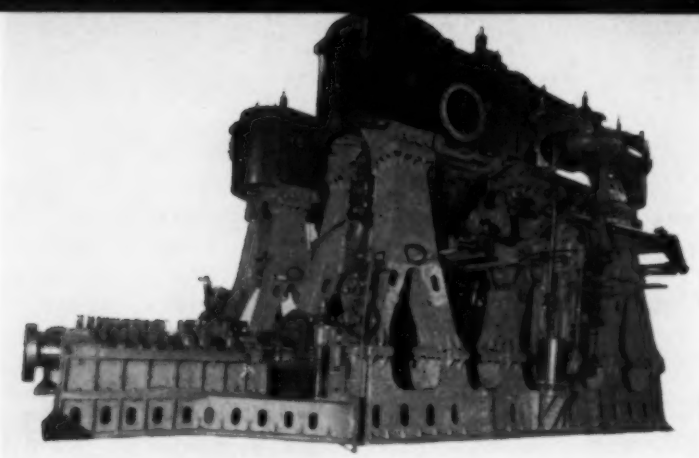
The turn of the tide in Canada's shipbuilding industry as evidenced in the foregoing was, no doubt, due to rumours of war. The figures for 1938 will reflect the imminence of war and with the war itself upon us in 1939, the slump of the post-war years, 1930-1937, would appear to be well past and further rapid advances in the industry assured.

The official list of vessels on the registry books of the Dominion of Canada at the beginning of 1939 showed that there are 450 vessels of 500 tons and over which include about twenty ocean-going passenger and cargo vessels and ten ocean-going oil tankers, the remainder consisting of vessels employed on the Great Lakes, inland waters and coastal services. While many of the larger ships were built in British shipyards, many of the coastal and lake vessels as well as the large number of smaller fishing and pleasure crafts not included in this total are the product of



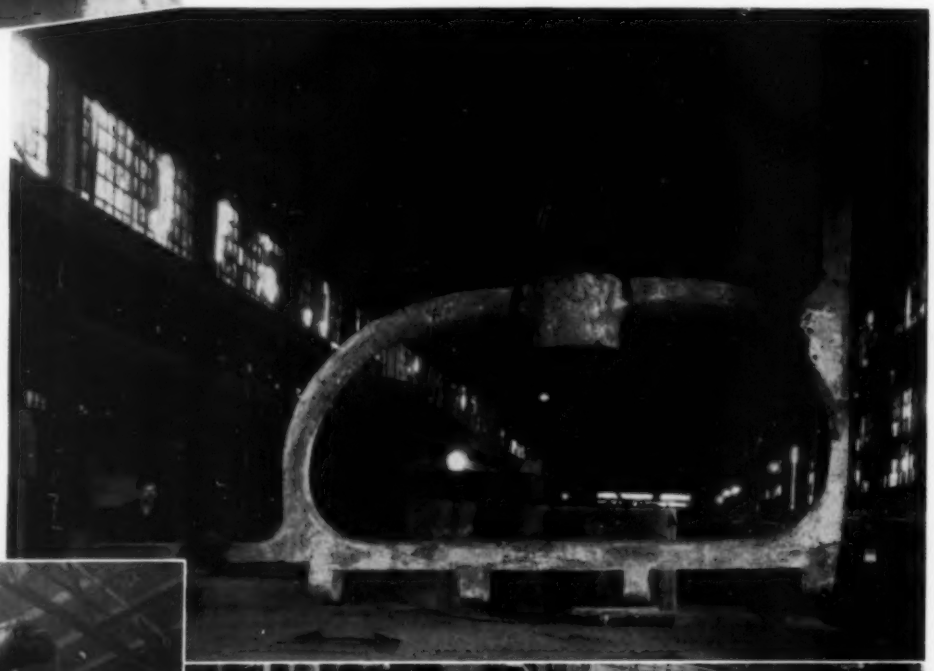


Wood still plays its part in the shipbuilding trade — a trade which has diminished in recent years but could, without difficulty, be revived and greatly extended. Scenes reminiscent of the Great War.



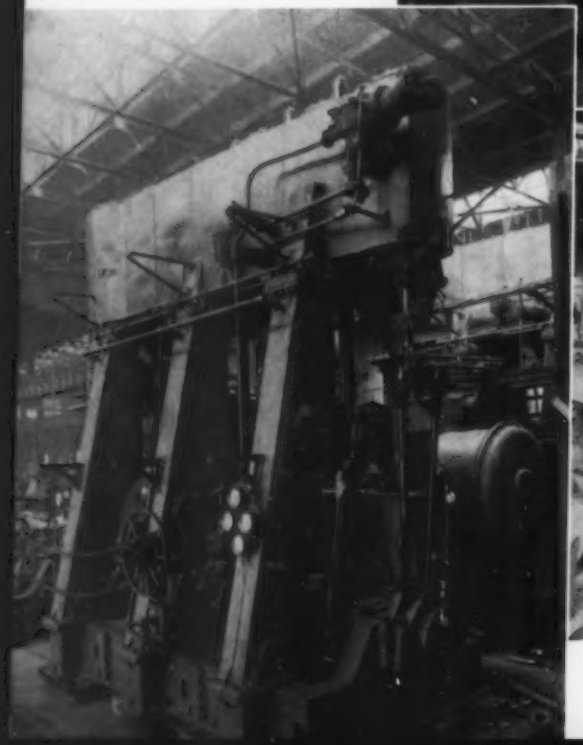
Above:—Twin screw triple expansion engines for the Maritime-built Government ice-breaker *N. B. McLean*. Length 260.0', breadth 60.3', depth 28.7'.

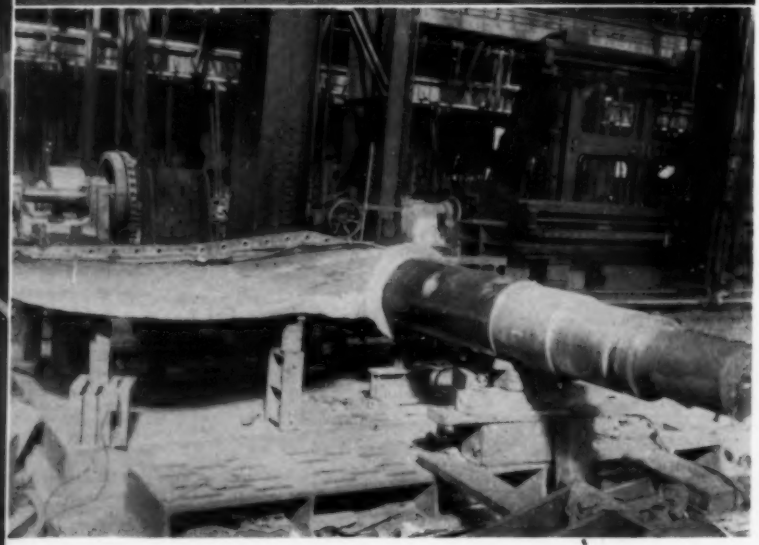
Below:—Canadian foundries can supply all steel castings for ship construction. A cast-steel stern frame made by an eastern firm for a large ocean-going vessel.



Above:—Lock gate electrically-driven lifter capable of lifting gates 500 tons in weight, built in a Canadian shipyard.

Below:—Equipment used in shipbuilding. Marine engine ready for installing.



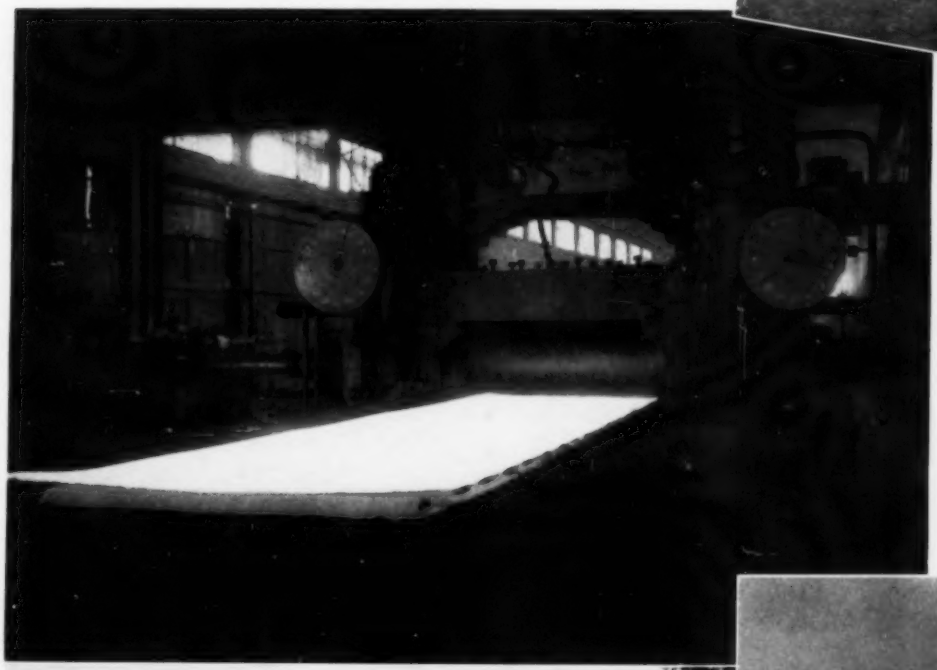


Stock of cast-steel rudder for C.P.S.S. *Montrose*, 1925.

Photo by Rice

Above:—Another type of large casting for an ice-breaker.

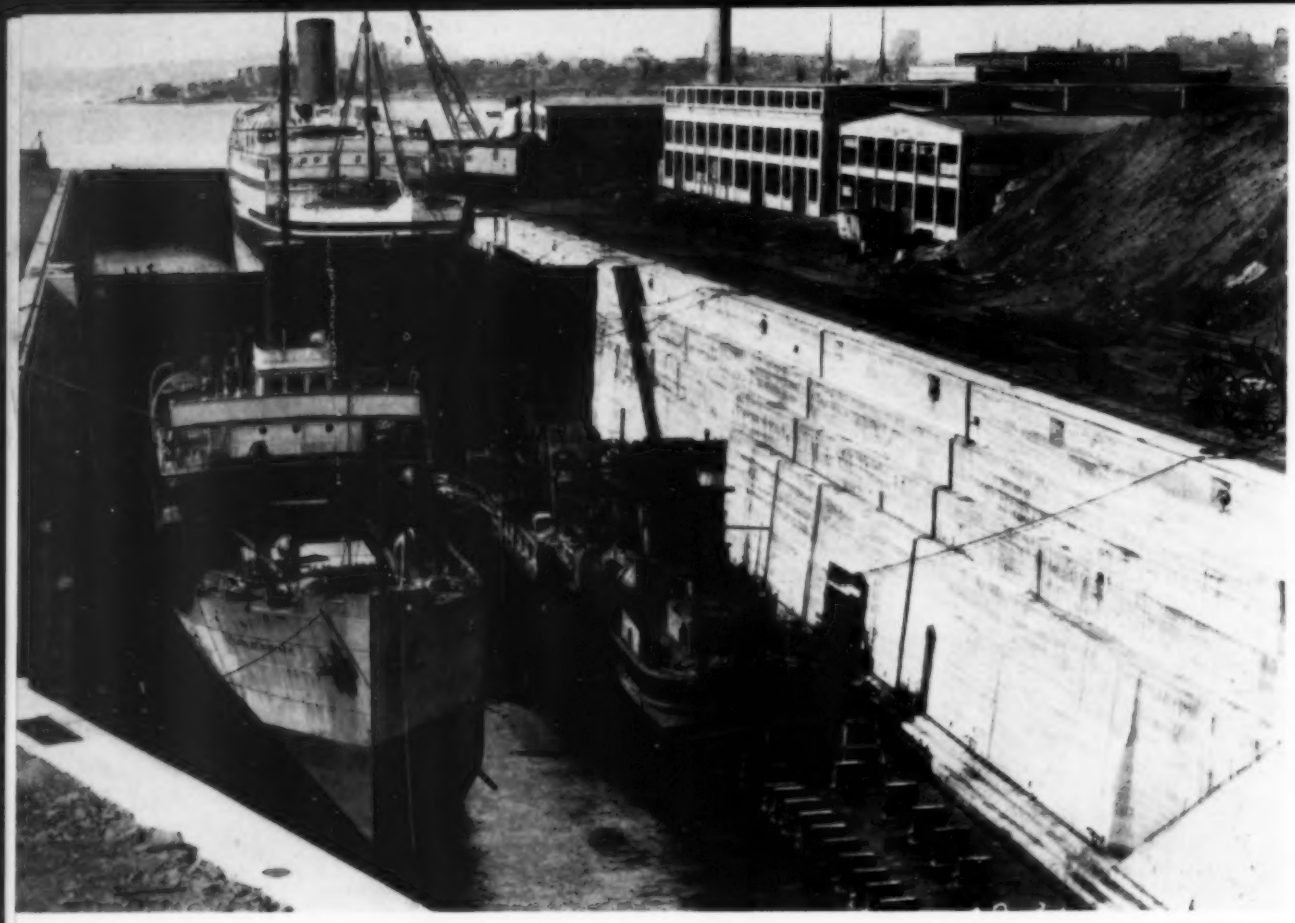
Below:—Canadian mills are equipped to furnish all the steel plates required by the shipbuilding industry from coast to coast. Rolling sheared plate 78 inches wide.



Above: — 14,000-pound steel casting for a Government ice-breaker.

Below: — A 31-ton cast-steel rudder for C.P.S.S. *Montrose.*

Ontario built Scotch marine boilers, 15' 6" diameter x 11' 6" long, built for the 3,254 gross ton ice-breaker *N. B. McLean.*



Canada possesses dry docks of a capacity that will accommodate the largest liner.

Canadian shipbuilders in Canadian yards. These figures indicate that Canada has practically no ocean-going marine of her own other than the Canadian National Steamship service trading to the British West Indies and some of the Canadian Pacific ships. The Dominion thus has to rely on British and neutral shipping to carry most of her overseas commerce.

Canada has built up a vast foreign trade which has placed her among the leading exporting nations of the world. The expansion of this foreign trade has been greatly facilitated by the development of the shipping facilities of Canadian ocean harbours on the St. Lawrence waterways, the Atlantic Coast and on the Pacific. The extent that these harbours are used by world shipping is indicated by the fact that in the last fiscal year 27,500 ocean-going vessels with a registered tonnage of 31,353,871 and 89,487 coastal and lake vessels with a tonnage of 58,807,702 arrived in Canadian ports.

Canadian coastal and Great Lakes' trades have almost exclusively occupied the industry of late years as indicated in the types of vessels built, namely, ice-breakers, patrol vessels, cargo vessels, oil tankers, ferries, tugs, dredges and grain barges. With Canada at war, however, not only will the building of peace-time craft be stimulated, but new craft peculiar to the exigencies of war-time needs will be in great demand. The building experience of one firm in the Province of Quebec during the Great War (1914-18) will serve to illustrate what might reasonably be expected: one ice-breaker, one dredge, twenty-four submarines, 214 submarine chasers, forty-three mine-laying trawlers, drifters and minesweepers (84 to 130 feet long), seven 400-foot cargo vessels, six 380-foot, and two 320-foot cargo vessels. This evidence of capacity of a quarter of a century ago is equally evident to-day.

It is rather remarkable to find the shipbuilding industry of the Dominion as intact as it is to-day, and adaptable to expansion. Despite the difficulties she has experienced, Canada has always held a

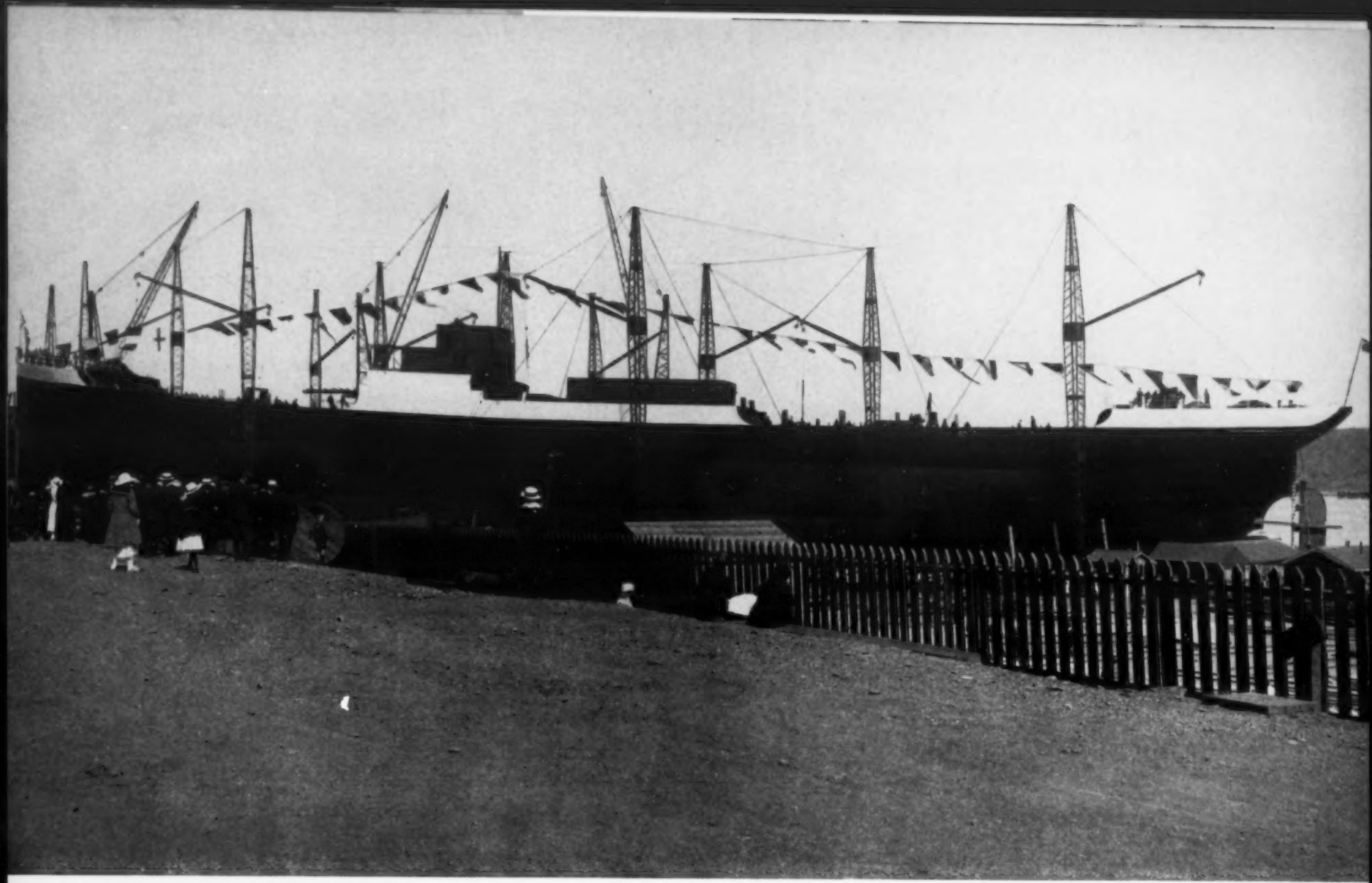
high ranking position among the ship-owning nations of the world, but since 1919 there has been very little to encourage it.

Shipbuilding in Canada is much older than most people realize. It goes back to the very early days of Canada's history, to the era of wooden ships and iron men. It took seamen of the Anglo-Saxon races to sail ships, some historian has said. The French were the first colonists along Canada's Atlantic Coast, and the first ships built in what is now Canada were built by them. However, they confined their shipbuilding efforts to the St. Lawrence River in those days when Canada's fate was being decided; and it was not until after the coming of the British that the industry branched out in New Brunswick, Nova Scotia, and to a lesser extent, in Prince Edward Island. The value of the timber growing in these provinces for ship purposes was soon realized by the British, and the reservation of trees suitable for masts became a governmental policy. One wonders if the pioneers in Quebec and the Maritime Provinces ever dreamed of the immense proportions this industry was to assume in later years.

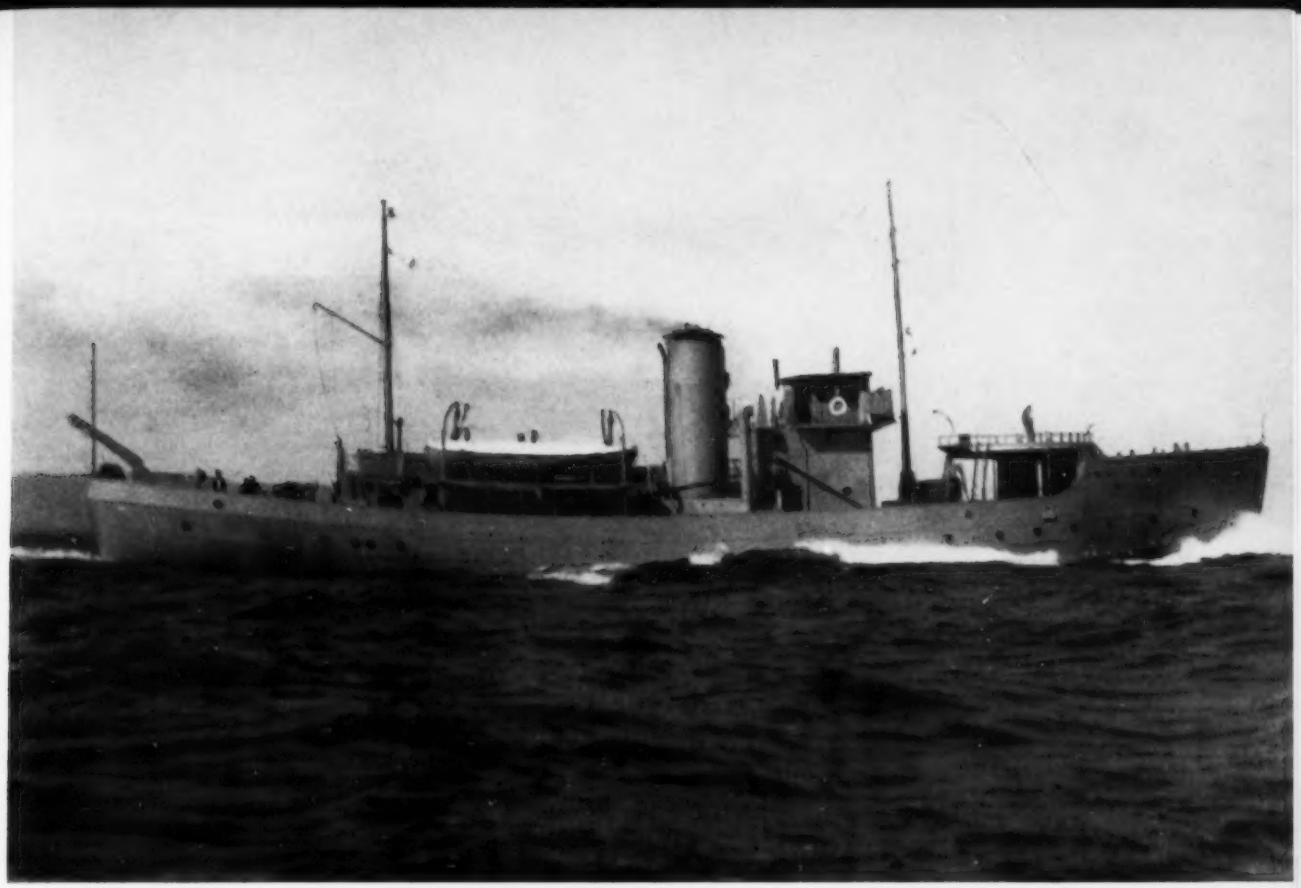
The pioneer effort in New Brunswick, was made in 1770, when James Simonds had a schooner built at what is now Saint John. Launched, rigged, and fitted out, she gave her owner highly satisfactory service for many years under the name of *Betsy*. In Nova Scotia the beginnings of what was to develop into a great industry for the Bluenose province came in 1751 when John Gorham built a brig with slave labour at Halifax. Soon small shipyards began to sprout up along the banks of creeks, rivers, and coves in Quebec and the three Maritime Provinces. Sturdy sailing vessels began to slide down the ways: the beginnings of pioneer effort had been well and truly laid.

The industry's early history had some interesting developments, the most noteworthy of which took place in the period, 1840-1880, the golden era of shipbuilding in Canada, when the Maritime Provinces and

One of Canada's floating docks. A scene during the Great War of 1914-18.

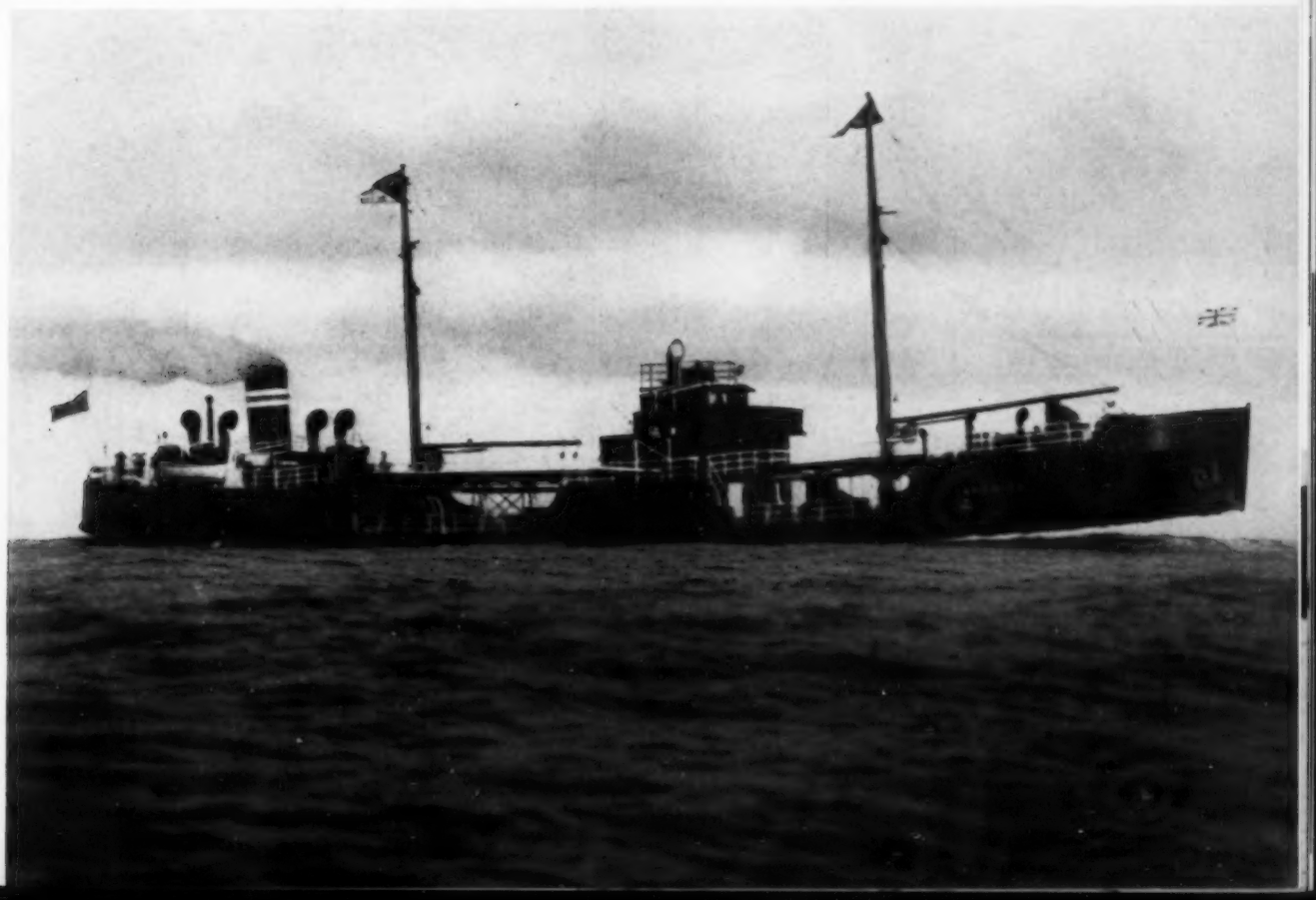


C. G. M. M. 5,384 gross ton *Canadian Mariner* ready for launching in the fall of 1920. Length 399.3′, breadth 52.3′, depth 28.4′.



H.M.C.S. *Fundy* — one of the minesweepers built for the Canadian Navy in 1938 by an Ontario shipyard, complete with engine and boiler.

An all-welded Diesel-driven oil tanker built in Eastern Canada for service on the Pacific Coast. Power is transmitted to the propeller by a magnetic clutch.



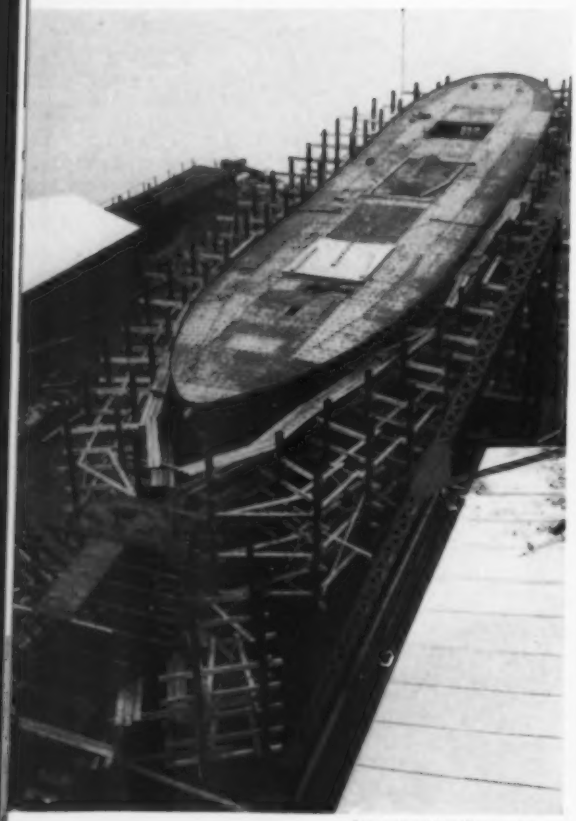


Photo by Max Sauer, Jr

Spacious Canadian plants provide ample facilities for the various demands in large shipbuilding operations.

Quebec placed Canada fourth among the ship-owning nations of the world with, in 1878, a flotilla of 7,196 vessels, aggregating 1,333,105 tons. These ships captured a huge share of the world's carrying trade and established a reputation for native-born seamen that became a legend in nautical history, and secured for Canada an assured place as a shipbuilding country.

During this era of expansion, the forests provided the material for the ships; pine, spruce, black birch, and hackmatack abounded in the forests of these provinces and were the principal woods used in ship construction. Great Britain built her wooden ships of oak and teak, but while red and white oak grows in Eastern Canada, it is interesting to note that it has not made a successful wood in shipbuilding in this country, even to this day.

In the earlier years of Canada's shipbuilding era practically all the ships were iron-fastened; later on, copper fastenings were used below the water-line and iron above, then came copper-galvanized iron fastenings. The Canadian-built ships in the North American trade were not sheathed as a rule with metal. Some, however, were sheathed with hard wood to save the hull from the wear and tear of ice. Iron work and fittings were usually made by the shipbuilder's blacksmith or by persons who did such work in the town where a shipyard was located. The sails were often secured from sailmakers in Quebec, Saint John, and Halifax. Patent and standard fittings, such as windlasses, capstans, steering gear and pumps, were imported at first from the United States or Great Britain and later made in Canada.

A saw-mill, a good blacksmith outfit, and men handy with adze, axe, and auger, along with a foreman shipwright formed the basis of the yard for these ships. No blue-prints were used in designing the ships. The shipwright took off his lines from a small wooden half-model previously prepared by himself or some old sea captain. Better equipped yards built the larger vessels of 1,000 to 2,400 tons.

Shipbuilding was profitable in those times. As an illustration of this, one ship of 1,887 tons, built for $53 a ton, sold for more than $100,000, realizing for her builders a profit of something more than $20,000.

Even as to-day, certain world-wide conditions or events affected the fortunes of the industry in those times. For example, the year 1853 was one of tremendous activity in the yards of the four provinces. The reason for this was due to a great demand for ships in the Australian and New Zealand trades, and for ships to transport troops and supplies to the Crimea, where Britain and France were waging war with Russia. Again, in the seventies, the discovery of oil in Pennsylvania gave a great impetus to the ocean carrying trade, and employment to a host of Canadian vessels to freight petroleum across to Europe. In addition to this, guano from the Chinahas provided cargo for many a Bluenose ship at this period.

To Quebec goes the honour of having built the first steamship to cross the Atlantic from Canada under her own steam. This was the famous *Royal William*, built by John Goudie in Black and Campbell's shipyard at Cape Cove, Quebec, and launched in April, 1831. Of Canada's many fine wooden sailing-ship builders, the names Henry Eckford and Donald McKay stand out. Henry Eckford, characterized as the "father of naval architecture in America", came out from Scotland when sixteen years old and settled at Quebec, with his uncle, who, with his partner, John S. Campbell, operated a shipyard at Cape Cove, Quebec.

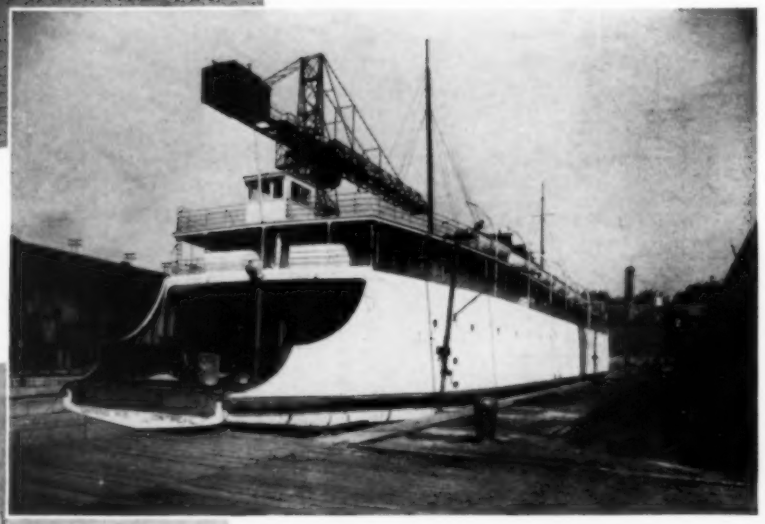
Young Eckford, after five years with his uncle, went to the United States, where his designs won him fame as the founder of a new school of naval architecture.

Donald McKay will ever remain identified with the glorious era of the clipper ships. This designer, born at Jordan River, near Shelburne, Nova Scotia, in 1810, designed and built more wooden clipper ships than any other builder, and almost every vessel he fashioned made a name for herself. His designs are the admiration of naval architects to-day.

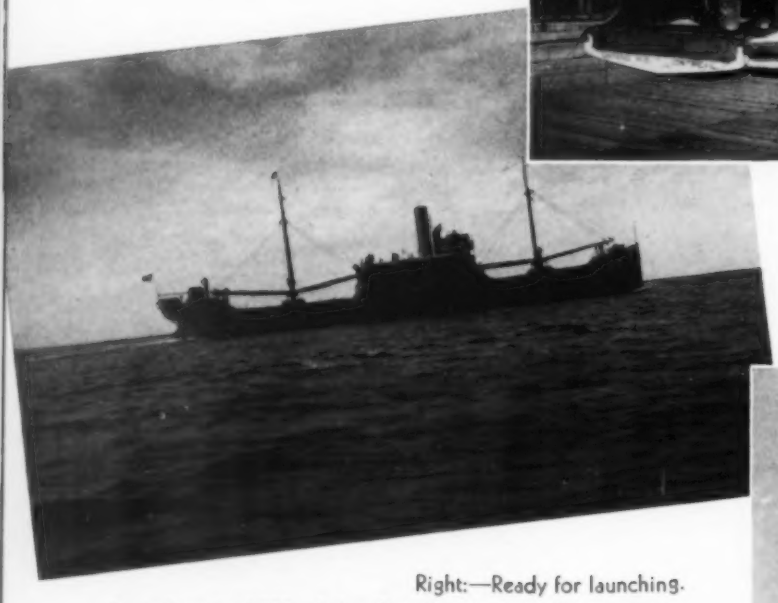
The Canadian vessels of the olden days carried some queer names. At Quebec in 1852 one was built and christened the *Banker's Daughter*. In 1855 a schooner was built at Saint John and christened *Go-*

Foundation Jupiter (135.0′ x 35.1′ x 10.5′), salvage vessel built in 1928. Gross tonnage, 466.

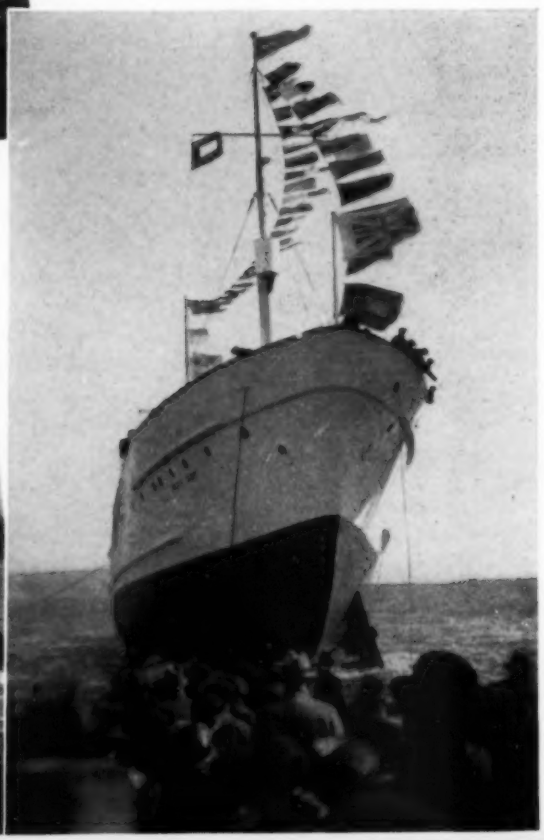
Photo by Ward and Davidson.



Ontario No. 2, a car ferry built in 1915 and used on inland waters. Gross tonnage, 5,568; length, 307.5′, breadth 54.0′, depth 20.2′.

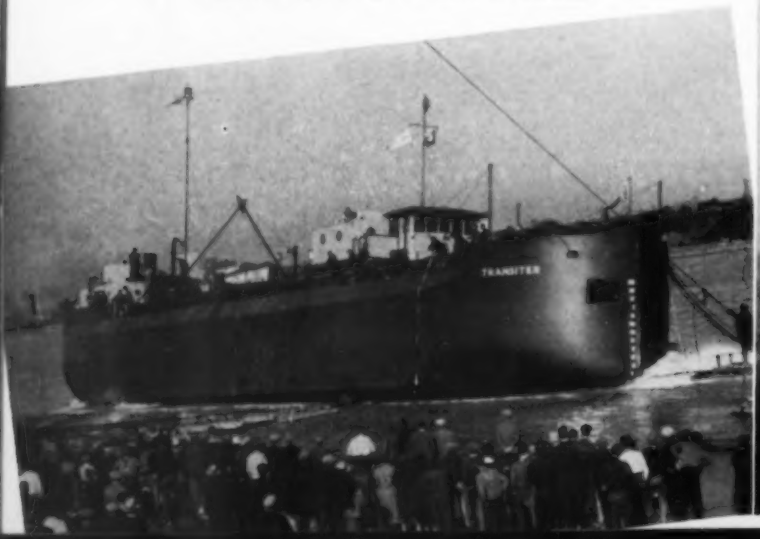


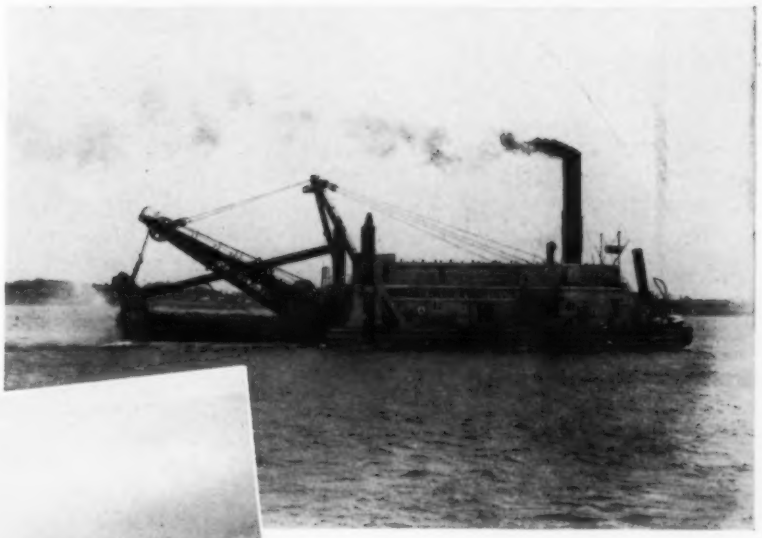
C. G. S. *Thiepal* illustrating type of boat used in Pacific waters by the Fisheries Protective Service.



Right:—Ready for launching.

Launching in 1935 of the Canadian built 1,117 gross ton M.V. *Transiter* (201.5′ x 34.3′ x 15.3′); one of the many tankers operating in Eastern Canada.



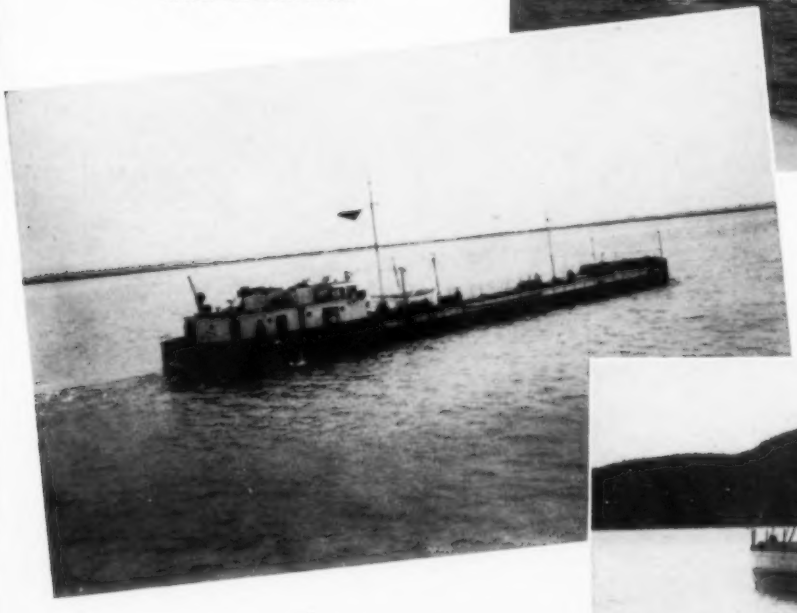


Midland (130′ x 43′ x 13′ 6″), dredge built in 1931 exemplifying yet another product of Canadian industry.

Photo by S. J. Hayward.

Ontario ferry *The Quints* (length 69′ 6″, breadth 32′) equipped with Diesel engine.

M. V. *Rimouski* built in 1939 by a Quebec shipyard for service in the lower St. Lawrence.



Tanker *Peter G. Campbell*, 836 gross tons (178.9′ x 34.1′ x 14.9′), converted from a tow barge.

Photo by Associated Screen News Limited.

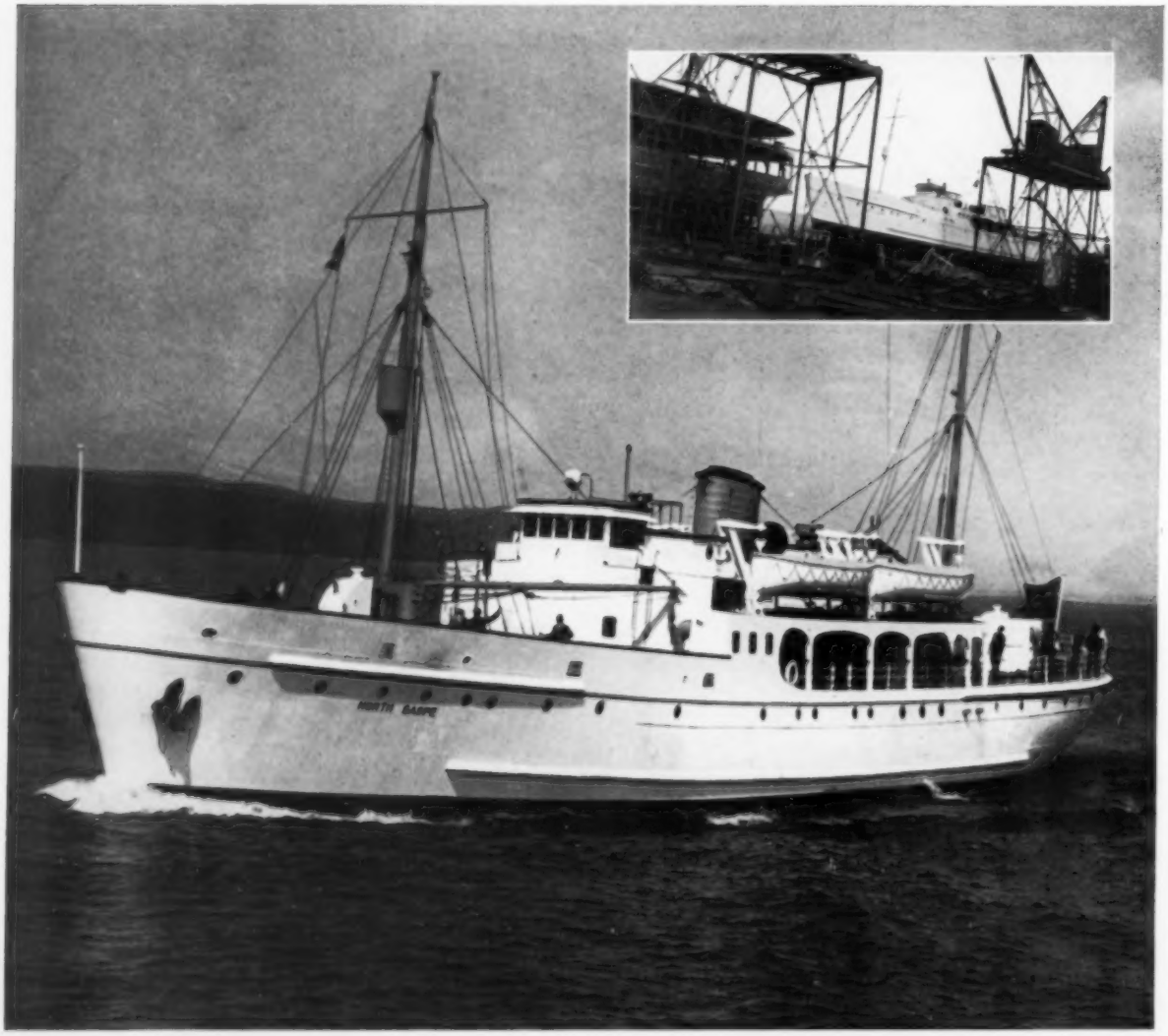
Scow 50, built in 1939 by a central Canadian shipbuilding company for use on an inland lake. Approximately 60 tons of ¼″ and 5/16″ steel plate were used in its construction.

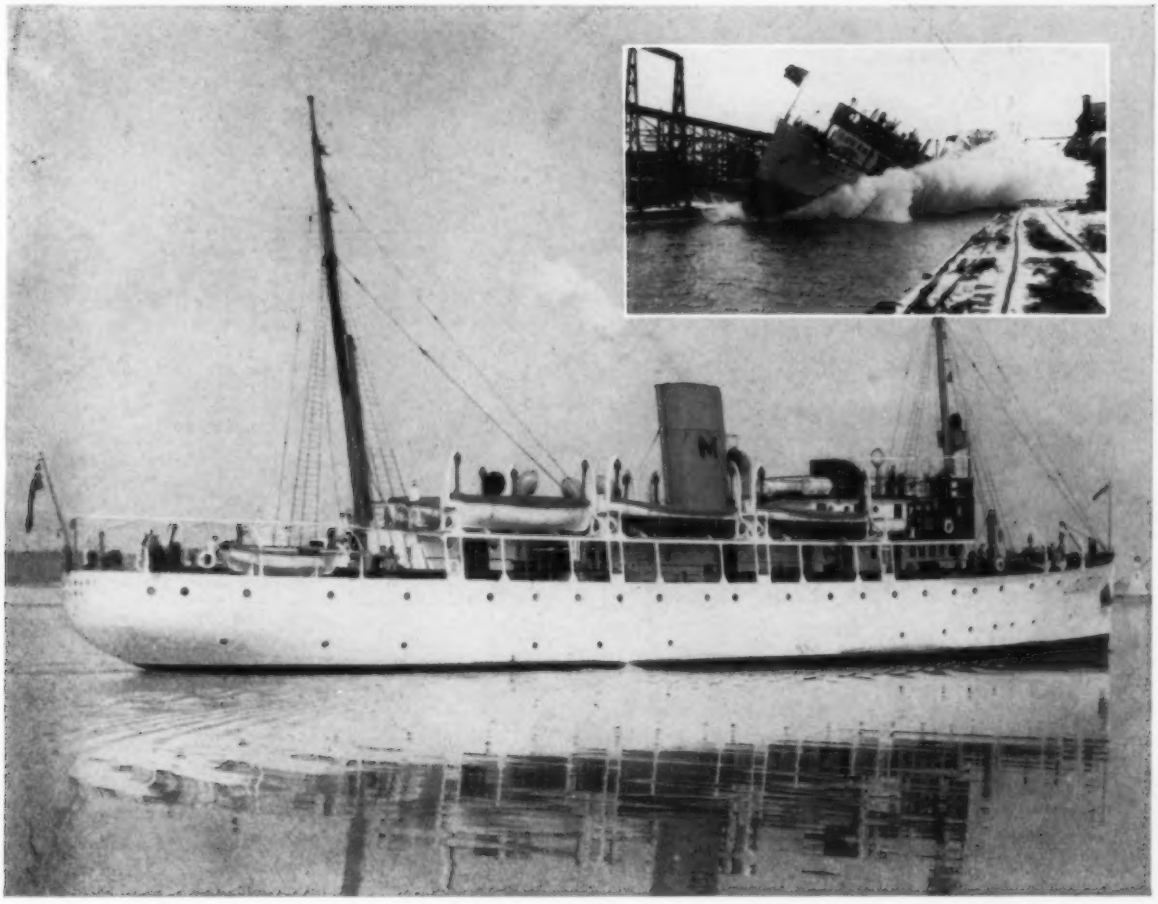
ask-her and in 1877 a schooner built at Yarmouth bore the name *Essence of Peppermint*.

The nineties saw Canadian shipowners disposing of their large wooden vessels as quickly as possible as an unprofitable operation. A new era had arrived: the steel-built vessel was now destined to supersede the clippers of Maritime fame and while it is true that the building of schooners and fishing smacks is still an active business in the Maritime Provinces to-day, practically every 100-foot and over vessel is now being built of steel; the wooden part of the trade is therefore relatively small. The steel era in shipbuilding resulted in the concentration of the shipbuilding work in a few major plants, and with the outbreak of the Great War a further concentration is evidenced in the modern shipyards of to-day.

The question of competent labour for the shipyards presents no problem in Canada. On the Atlantic and Pacific Coasts, for example, many men skilled in shipbuilding are idle, others employed in work unrelated to their training and easily replaced; a further source of expert labour is to be found in crews of the fishing fleets, also idle. A registration of such men would seem in order, if indeed it is not already under way. The Maritimes breed men of the sea, men who would be an asset to any shipyard, men who come from a race of shipbuilders whose forebears built the world-famous champion

M.V. *North Gaspé*, 888 gross tons (188.2′ x 35.1′ x 18.1′), steamship built in Quebec in 1938.
Inset: — Launching of M.V. *North Gaspé*.





Twin screw steamer C.G.S. *Wm. J. Stewart*, 1,295 gross tons; length 214.0′, breadth 36.1′, depth 15.1′; built in 1932 for Hydrographic Survey Service on the Pacific Coast. Inset:—Side launching of C.G.S. *Wm. J. Stewart*.

Bluenose. Queen of the North Atlantic fishing fleets. Men of equal ability and knowledge of shipping are to be found on Canada's Pacific Coast, on the shores of the Great Lakes and St. Lawrence. Canada need not fear for lack of men. They are ready.

Undoubtedly the Government has in its possession complete reports of the capacities of all shipbuilding plants, their possibilities for expansion and the types of craft they are in a position to supply to meet present requirements. We may expect with confidence that every safeguard will be applied to insure the maintenance of high standards for ships which Canada's shipyards will produce. The industry is working in close co-operation. Canada possesses a strategical geographical position, she has the trained personnel and assistants—promising young men to act as apprentices, and the requisite raw materials within her borders or just across her neighbour's line.

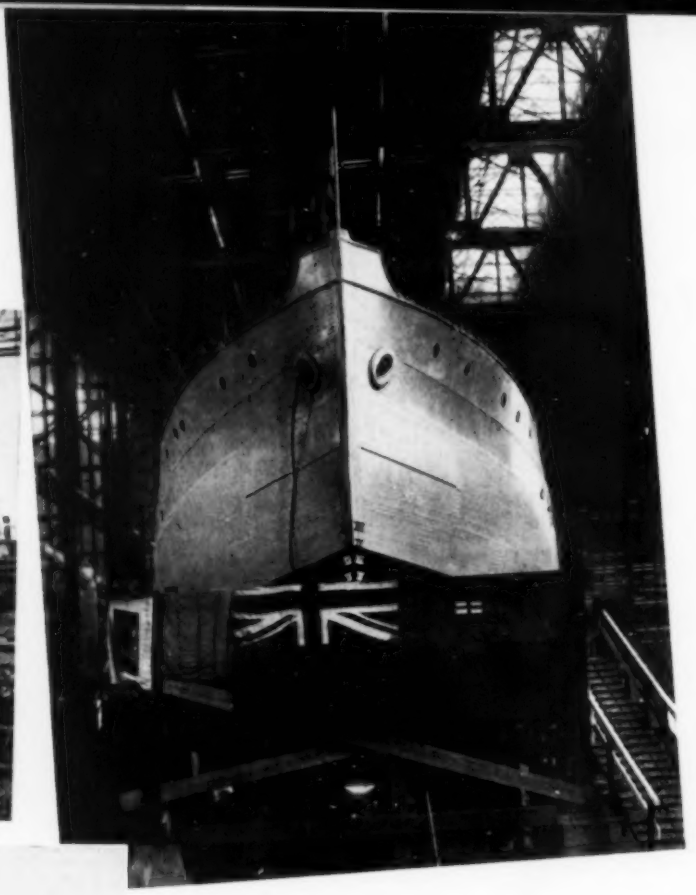
Canada's shipbuilding industry, as in the past, is going into action to meet any demands which war-time requirements may make upon it, but not only this, she will also be ready with minimum expense to pursue the path of Peace when it comes.

Grateful acknowledgment is made to the following for their assistance in text and illustrative material: Department of National Defence; Department of Transport; Department of Trade & Commerce; Canadian Vickers Limited; Marine Industries Limited; Dominion Foundries and Steel, Limited; Canada Steamship Lines, Limited; Halifax Shipyards Limited; Yarrows Limited; Shelburne Shipbuilders Limited; Transit Tankers & Terminals Limited; Burrard Dry Dock Company, Limited; Canada Steamship Lines Limited; The Collingwood Shipyards, Limited; Canadian Steel Foundries, Limited; Foundation Maritime Limited; Russel Bros., Limited; St. John Dry Dock and Shipping Company, Limited; Montreal Dry Docks, Limited; Midland Shipping Company, Limited; Davie Shipbuilding Company, Limited; Clarke Steamship Company, Limited; Lambert, German & Milne.

Canadian Government ice-breaker *Saurel* (200.0′ x 42.0′ x 19.3′), 1,176 gross tons, built in 1929. Note reinforced bow.

Photo by S. J. Hayward.

Below: — Laying the keel of the S. S. *Stadacona*.

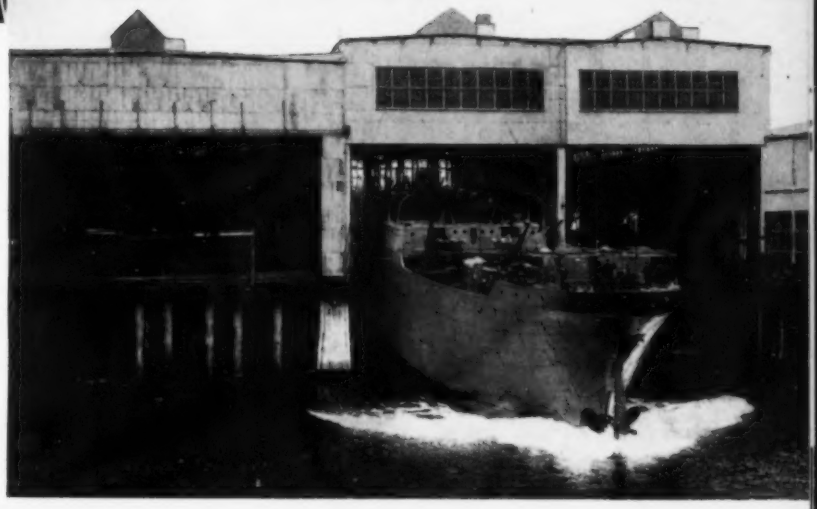


Left: — Canada's capacity to build large ships is exemplified in this 9,181 gross ton product of an Ontario shipbuilding plant. The S. S. *Stadacona* ready for launching, 1929. Length 582.0′, breadth 60.2′, depth 28.3′.

Bottom left: — Launching in 1938 at one of British Columbia's shipyards of H.M.C.S. *Nootka*, 2,069 gross tons, (251.3′ x 43.9′ x 20.3′).

Left:—Bow view of 4,342 gross ton *War Faith* ready for launching. Length 380.0', breadth 49.2', depth 26.7'.

Below:—Aft end of the 470 gross ton M. V. *Matane I* (147.2' x 32.6' x 12.5') before the launch.



Right:—Launching of another product of Canadian shipyards.

Bottom right: — Minesweeper built at a Canadian shipyard.

Photo by Jack Wardlaw Limited.

Bottom centre:—Canadian Government 316 gross ton patrol vessel *Fleurdelis* (164.8' x 21.1' x 11.7') built in a Quebec shipyard in 1929. The keel and floors of the ice-breaker *Saurel* are also shown.

Photo by Street Photo Supply Company.

Top left:—The "Roof of the Continent" and Athabaska Glacier issuing from the great Columbia Ice-field whose rivers of ice drain into three oceans, the Pacific, Arctic, and Atlantic.

Top right:—Mount Rundle and Echo Creek representing the tilted fault-block type of mountain with a gentle west slope and a precipitous east face. (Photo 1).

Centre right:—Mount Ishbel, a tightly folded anticlinal mountain whose steeply dipping beds weather into high smooth cliffs, cock's-comb ridges and needle-shaped peaks. (Photo 2.)

Lower left: — View from Sulphur Mountain looking east down Bow River Valley and across Cascade River coal basin to Palliser Range, showing Tunnel Mountain (in lower foreground) and Lake Minnewanka Valley (in centre distance). (Photo 3.)

GEOLOGY OF THE NATIONAL PARKS OF CANADA IN THE ROCKIES AND SELKIRKS

by **B. R. MacKAY**

WESTWARD from the Canadian prairies the level landscape of the plains gradually gives place to the undulating topography of the foothills, and this, in turn, is abruptly terminated by a great rampart towering several thousand feet above the general level and consisting, throughout most of its length, of steel-grey limestone. The base of this escarpment, lying 3,200 feet or more above sea-level, marks the eastern edge of the belt, 60 to 80 miles wide, of north-westerly-trending and overlapping mountain ranges collectively known as the Rocky Mountains. (See map).

These mountains form the great backbone of the continent: they extend from south of the International Boundary north to beyond the Liard River, a distance in Canada of over 900 miles. Within this belt numerous peaks rise above 11,000 feet, the highest, Mount Robson, having an elevation of 12,972 feet.

The Rocky Mountains are bordered on the west throughout their entire length by a trough or depression which varies in elevation from 2,300 to 3,000 feet, and extends from Flathead Lake in Montana north-westerly to the Yukon. This great depression, known as the "Rocky Mountain Trench," is one of the most remarkable topographic features in the whole Cordilleran or western mountain belt. It is occupied from south to north successively by the headwaters of Kootenay, Columbia, Canoe and Fraser Rivers, and farther north by tributaries of the Peace and the Liard.

West of this great trough in southern British Columbia is a succession of three overlapping mountain systems known as the Purcell, Selkirk, and Columbia, each of which extends southerly into the United States. Each system is truncated obliquely on its northern end by the Rocky Mountain Trench, suggesting that all three were formed prior to the Rockies and that they are structurally separated from them by the trench. The Purcell System, the most easterly of the three, is commonly regarded as part of the Selkirk System, but it is separated from the Selkirk System by a great fault valley, the "Purcell Trench", which is occupied successively from north to south by Beaver River, Duncan River, Duncan Lake, Kootenay Lake and Kootenay River. The Selkirk System lies within the great northern loop of the Columbia River and extends southward to beyond the International Boundary, a distance in Canada of 250 miles. It has an average width of 40 miles and is bounded on the west by the valley of the Columbia River and Arrow Lakes, referred to geologically as the "Selkirk Trench". As the valley of the Columbia River at Revelstoke is at an elevation of 1,500 feet, and the highest peak, Hasler Peak, has an elevation of 11,123 feet, there is a vertical relief within the Selkirks of over 9,600 feet. The Columbia System lies on the west of the Selkirk Trench. It has a width of about 50 miles and extends north-westerly from the International Boundary to the headwaters of the Thompson, Fraser and Canoe Rivers, a distance of 325 miles. Toward the west the mountains of this system become gradually lower and plateau-like in character and merge into the Belt of Interior Plateaux.

The Rocky and Selkirk Mountain Systems comprise some of the most scenic alpine territory to be found anywhere. They form a veritable "Sea of Mountains" in which the roughly parallel ranges rise like waves one after another as far as the eye can reach. Ever since David Thompson, the celebrated fur-trader, explorer, geographer, astronomer and scientist, explored the passes of the Rocky Mountains over 125 years ago, additional marvels of scenic grandeur in mountain structure, canyon and subterranean erosion, extensive ice-fields, glaciers, and glacial sculptured landforms, have come to the notice of successive scientists and explorers, and vast areas of as yet uncharted mountain territory still challenge the daring mountain-climber, the adventurous explorer and the enquiring naturalist. The deep drainage channels that have been cut through the heart of these mountain ranges have laid

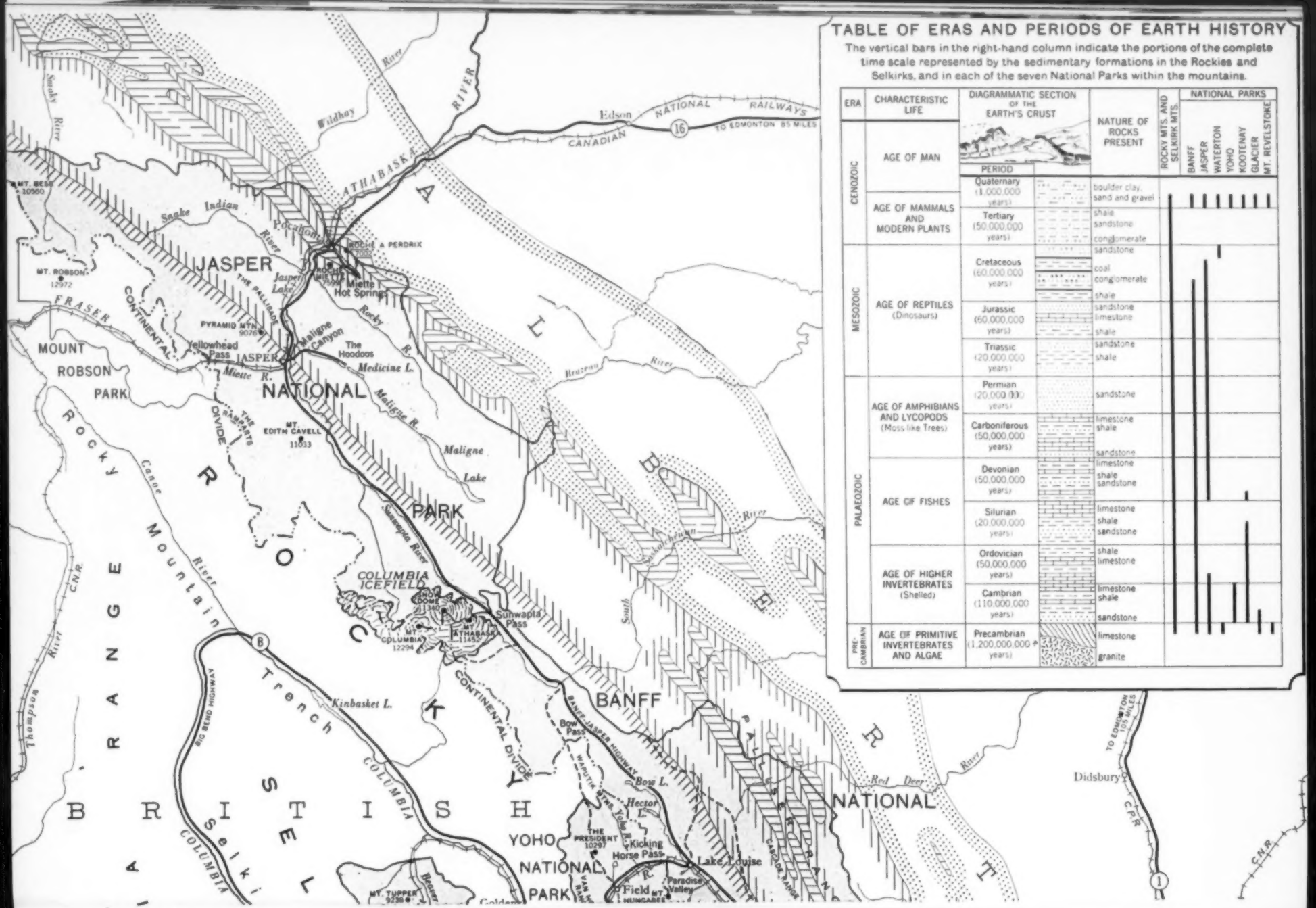
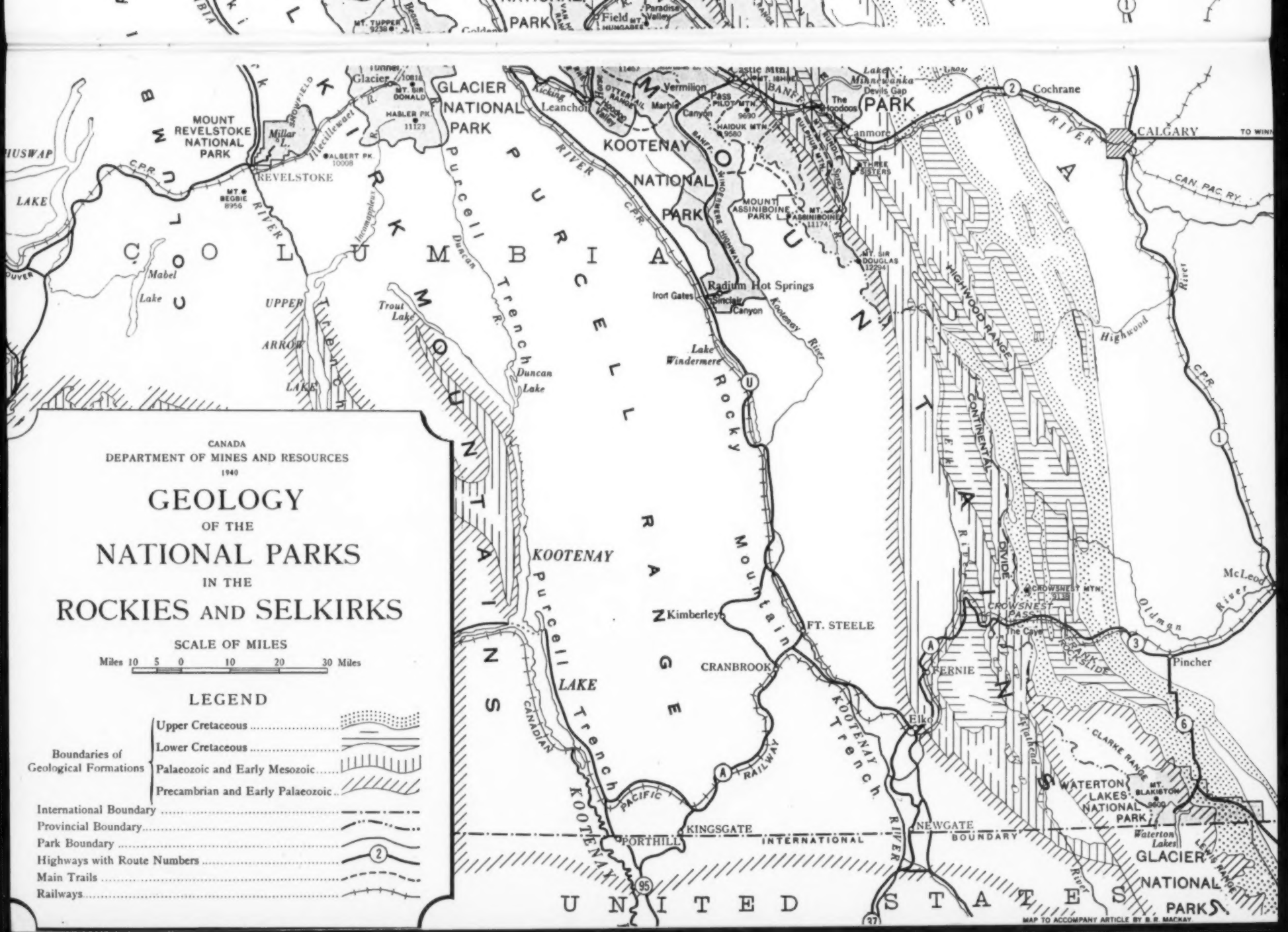


TABLE OF ERAS AND PERIODS OF EARTH HISTORY
The vertical bars in the right-hand column indicate the portions of the complete time scale represented by the sedimentary formations in the Rockies and Selkirks, and in each of the seven National Parks within the mountains.
ERA
CHARACTERISTIC LIFE
DIAGRAMMATIC SECTION OF THE EARTH'S CRUST
NATURE OF ROCKS PRESENT
NATIONAL PARKS
ROCKY MTS. AND SELKIRK MTS.
BANFF
JASPER
WATERTON
YOHO
KOOTENAY
GLACIER
MT. REVELSTOKE
PERIOD
CENOZOIC
AGE OF MAN
AGE OF MAMMALS AND MODERN PLANTS
Quaternary (1,000,000 years)
boulder clay, sand and gravel
Tertiary (50,000,000 years)
shale
sandstone
conglomerate
MESOZOIC
AGE OF REPTILES (Dinosaurs)
Cretaceous (60,000,000 years)
sandstone
coal
conglomerate
shale
Jurassic (60,000,000 years)
sandstone
limestone
shale
Triassic (20,000,000 years)
sandstone
shale
PALAEOZOIC
AGE OF AMPHIBIANS AND LYCOPODS (Moss-like Trees)
Permian (20,000,000 years)
sandstone
AGE OF FISHES
Carboniferous (50,000,000 years)
limestone
shale
sandstone
Devonian (50,000,000 years)
limestone
shale
sandstone
Silurian (20,000,000 years)
limestone
shale
sandstone
AGE OF HIGHER INVERTEBRATES (Shelled)
Ordovician (50,000,000 years)
shale
limestone
Cambrian (110,000,000 years)
limestone
shale
sandstone
PRE-CAMBRIAN
AGE OF PRIMITIVE INVERTEBRATES AND ALGAE
Precambrian (1,200,000,000 + years)
limestone
granite
Edson
NATIONAL RAILWAYS
CANADIAN
TO EDMONTON 85 MILES
ATHABASKA RIVER
Wildhay River
Smoky River
MT. BESS 10960
Snake Indian River
Pocahontas
ROCHE A PERDRIX
JASPER
MT. ROBSON 12972
Jasper Lake
Miette Hot Springs
THE PALISADES
FRASER
CONTINENTAL
PYRAMID MTN. 9076
Yellowhead Pass
JASPER
Maligne Canyon
The Hoodoos
Medicine L.
Rocky R.
Miette R.
MOUNT ROBSON PARK
NATIONAL
Maligne R.
THE RAMPARTS
DIVIDE
MT. EDITH CAVELL 11033
Maligne Lake
ROCKY MOUNTAIN TRENCH
Canoe River
Mountain
Thompson River
C.N.R.
PARK
Sunwapta River
COLUMBIA ICEFIELD
SNOW DOME 11340
MT. COLUMBIA 12294
MT. ATHABASCA 11452
Sunwapta Pass
Kinbasket L.
AVALANCHE
BIG BEND HIGHWAY
COLUMBIA
Selkirk
CONTINENTAL DIVIDE
BANFF
BANFF-JASPER HIGHWAY
Bow Pass
WAPUTIK
Bow L.
Hector L.
Red Deer River
NATIONAL
Didsbury
TO EDMONTON 100 MILES
C.P.R.
C.N.R.
THE PRESIDENT 10297
Kicking Horse Pass
YOHO
NATIONAL
PARK
Lake Louise
CARBON RANGE
Field
Paradise Valley
MT. TUPPER 9230
Golden


CANADA
DEPARTMENT OF MINES AND RESOURCES
1940
GEOLOGY
OF THE
NATIONAL PARKS
IN THE
ROCKIES AND SELKIRKS
SCALE OF MILES
Miles 10 5 0 10 20 30 Miles
LEGEND
Boundaries of Geological Formations
Upper Cretaceous
Lower Cretaceous
Palaeozoic and Early Mesozoic
Precambrian and Early Palaeozoic
International Boundary
Provincial Boundary
Park Boundary
Highways with Route Numbers
Main Trails
Railways
MOUNT REVELSTOKE NATIONAL PARK
GLACIER NATIONAL PARK
KOOTENAY NATIONAL PARK
BANFF NATIONAL PARK
YOHO NATIONAL PARK
WATERTON LAKES NATIONAL PARK
GLACIER NATIONAL PARKS
COLUMBIA MOUNTAINS
PURCELL MOUNTAINS
ROCKY MOUNTAINS
PURCELL RANGE
CONTINENTAL RANGES
HIGHWOOD RANGE
CLARKE RANGE
LEWIS RANGE
REVELSTOKE
Mabel Lake
ARROW LAKES
Trout Lake
Duncan Lake
Lake Windermere
Radium Hot Springs
Kootenay River
Columbia River
Bow River
Highwood River
Oldman River
McLeod River
Kimberley
FT. STEELE
CRANBROOK
FERNIE
Elko
Pincher
CALGARY
Cochrane
Canmore
Banff
Lake Minnewanka
Devils Gap
The Goodoos
Vermilion Pass
Marble Canyon
Kicking Horse Valley
Leanchoil
Mount Assiniboine Park
Mt. Assiniboine 11174
Mt. Sir Douglas 12294
Mt. Begbie 8956
Albert Pk. 10008
Hasler Pk. 11123
Mt. Sir Donald 10818
Mt. Tupper 9258
Paradise Valley
Field
Golden
Iron Gates
Sinclair Canyon
Kootenay Canyon
Duncan River
Illecillewaet R.
Incomappleux R.
Beaver R.
Goldstream R.
Shuswap Lake
Crowsnest Pass
Crowsnest Mtn. 9118
The Cave
Frankside
Divide
Waterton Lakes
Mt. Blakiston 9600
Kootenay Trench
Canadian Pacific Railway
Kingsgate
Porthill
Newgate
International Boundary
UNITED STATES
MAP TO ACCOMPANY ARTICLE BY S. P. MACKAY

bare the very roots of the mountains, and have exposed rocks which are among the most ancient of the earth's crust. The facilities offered by the two transcontinental Canadian railway systems that cross these ranges via the Crowsnest Pass in the south, the Kicking Horse Pass in the central part, and the Yellowhead Pass farther north, have opened up this immense alpine wonderland and have made it possible for the ordinary traveller to view, from the observation platform, an assemblage of scenic features unrivalled in any part of the world. Along these routes are exposed a sequence of rock formations representative of most of the geological time-scale from the earliest era in the earth's history to the present time. (See chronological table inset on map). In some places the rocks are flat-lying, in others they are gently warped, and over much of the mountain belt they are highly inclined, folded, faulted, and in places even overturned. From the train there can be observed many a glacier with its rock-basin lake exquisite in its hues of emerald and turquoise blue. From some nearby point of vantage can be counted more than a hundred cliff glaciers ornamenting the flanks of mountain ranges, these being accompanied and accentuated by a profusion of glacial-sculptured landforms in all stages of development.

The Canadian Government, fully conscious of the value of this alpine wilderness as a national asset, has, over a period of fifty-five years, set aside for recreational purposes and for preservation for future generations, seven large park areas embracing 8,720 square miles of the most easily accessible and picturesque parts of the Rockies and Selkirks. The locations of these seven national parks are shown on the accompanying map. The boundaries of each conform, as far as possible, to natural features such as watersheds and rivers. Three of the parks, Waterton Lakes, Banff, and Jasper, lie on the eastern or Alberta side of the Continental Divide of the Rocky Mountains; two of them, Yoho and Kootenay, lie on the British Columbia side of the Rockies, and the remaining two, Glacier and Mount Revelstoke, are located in the Selkirk Range farther west. All the parks possess features common to alpine regions, but each has, in addition, special characteristics and a beauty of its own. A few of the outstanding geological features are shown in the accompanying illustrations.

The Rocky and Selkirk Mountains have a complex history extending over a period of half a billion years, and involving the accumulation of great thicknesses of sediments, their upheaval, and the erosion of the uplifted masses into their present forms. Both mountain ranges consist largely of rocks that were laid down originally as sand, mud, and calcareous ooze in a more or less horizontal position in a broad inland sea that stretched from what is now California to the Arctic, occupying roughly the area where the mountains now stand. As the sea-bottom gradually subsided, bed after bed was added, one on top of the other, the character of the sediment and the thickness of the bed deposited at any one locality being controlled by the distance from the shore, the depth of the water, and the nature of the contributing agencies. As the sediments were being laid down, there were buried with them the remains of plant and animal life that existed at that time. Some of these were destined to be preserved and to contribute to a record of the gradual development of life upon the earth; in some beds the fossil content is meagre, and in others relatively abundant.

The earliest rocks in this region were laid down long before the life record began, and are, consequently, placed as Precambrian in age. (See inset on map). They are believed to have been derived by erosion from a land area that then stretched along the western side of the great inland sea. During successive geological ages the sea-bottom and foreshore on the west were raised above sea-level and in turn contributed by their erosion, detritus that made up the rocks of later geological ages, being deposited in the sinking sea basin that lay adjacent on the east. Thus the Precambrian rocks contributed to the Cambrian, the Cambrian and older contributed to the younger Palaeozoic, and the Palaeozoic and older to the Mesozoic sediments.

During the hundreds of millions of years that elapsed there were many oscillations of the sea-level, some of which resulted in the separation of the sea into several seaways, and the subjection of the intervening land areas to the agencies of denudation. In some localities the uplift was accompanied by extrusions of molten liquid rock from the earth's interior, which overspread large areas of the sea-bottom and greatly altered the sediments with which the hot rock came in contact.

The beginnings of the Selkirk and the Rocky Mountains date back to the time when each of these large areas was uplifted above water-level and subjected to the agents of denudation and erosion. It is believed that the Selkirk area was raised in late Cretaceous time estimated at a hundred million years before the uplift of the Rockies. The uplift in each case was very gradual, resulting in a steepening of the gradients of the existing streams and a corresponding increase in their erosive power. As a result the larger streams, by eroding their channels into the rising land, were able to maintain their original courses in spite of a tendency to cut new channels in harmony with the slopes formed by the uplift. This accounts for the major transverse valleys that cut across the structure of the mountains, such as the upper parts of Kicking Horse, Bow, Athabaska, Liard and Peace Rivers.

As the compressive forces directed from the west progressively increased through the settling of the large Pacific segment of the earth's crust, the uplifted areas gradually became arched upward, and folded, or broke into large blocks which were tilted and thrust one over the other to the east. It was this chain of events that produced the folded and faulted mountains of the Selkirks and Rockies and defined the major longitudinal breaks such as the Selkirk, Purcell, and Rocky Mountain Trenches, and the great longitudinal break extending along the eastern slope of the Rocky Mountains bringing Precambrian and Cambrian rocks in contact with those of late Palaeozoic age. The last and most pronounced of these breaks, which took place in late Tertiary time, is the great fault which forms the eastern border of the Rocky Mountains. Along this fault Palaeozoic and in the south Precambrian rocks have been thrust upward and eastward for many miles over much younger Cretaceous rocks of the Alberta foothills and plains. As a result of these overthrusts, fossil remains of ancient marine life entombed in the sediments that once formed the deep sea-bottom are now to be found on many peaks of the Rockies at elevations of over 10,000 feet.

The subsequent history of the mountains is largely a record of erosion and denudation by atmosphere, water and ice. The ultimate effect of these agencies is to wear down the uplifted masses and reduce them to base level, but for a long time the effect of such denudation is to increase the ruggedness of the region. The Selkirk Range being the older is, consequently, of lower relief and more rounded than the younger Rockies, but much of this mountain belt is also still in a youthful stage of erosion, being characterized by precipitous mountain scarps, deeply incised canyons, waterfalls and rapids and myriads of landforms that either have been or are being now sculptured by alpine glaciers.

The upturning and faulting of the rocks have made possible the exposures of great thicknesses of beds which otherwise would never have been known to exist, and these have extended considerably our knowledge of the geological history of the area. Every mountain scarp, canyon wall and waterfall reveals to the geologist some part of earth history. At no one area in the mountain belt is a complete sequence of the rock formations to be seen, but the data lacking at one locality can generally be supplied from some other nearby region. By correlating the data gathered by geologists in various areas a complete sequence of the rock formations of the whole area can be drawn up, and from a study of their fossil content, the different formations can be assigned to their proper place in the chronological world scale. (See inset on map).

The most complete representation of the various rock systems that occur in the Canadian Cordillera is to be found along the Canadian Pacific Railway through the Kicking Horse Pass. It has been estimated that along this route there is exposed in the Rocky Mountains alone more than 50,000 feet of conformable sediments, and the thickness of the strata in the Selkirks is believed to be almost as great. Along this route also, in the western Rockies and Selkirks, are large areas of ancient sedimentary rocks that have been intruded by rocks of volcanic origin at a much later geological period and in some places both rocks have been so altered by still later igneous intrusions that it is difficult to determine whether the rocks are of sedimentary or volcanic origin.

On the chronological table of "Eras and Periods of Earth History", that forms the inset of the accompanying map, is indicated the predominant nature of the sediments, and the portion of the sequence represented in the Rocky and Selkirk Mountains and in each of the seven national parks. As the tilting, folding and faulting to which the Rocky and Selkirk Mountains have been subjected make it impossible to outline on a map of small scale the narrow areas occupied by individual formations,

they have been grouped on the accompanying map, compiled from maps, reports and guide books issued by the Federal and Provincial Departments, into five major structural belts. From east to west these are:—

(1) Belt of Upper Cretaceous rocks lying along the front of the Rocky Mountains, and including a large basin of these rocks east of the Continental Divide in the Crowsnest Pass area, and several basins north of Jasper Park.

(2) Belt of Lower Cretaceous coal-bearing rocks bordering or completely surrounding narrow areas of Palaeozoic rocks and extending north-westerly and south-easterly along major structural valleys within the eastern Rocky Mountains of the Banff and Jasper Park areas, and including the Elk River, Fernie and Flathead coal basins of south-eastern British Columbia.

(3) Belt of Palaeozoic and early Mesozoic rocks that forms the greater part of the eastern Rocky Mountains of the Banff and Jasper Park areas, and including ranges of these rocks that extend south-easterly from the Banff Park area and north-westerly from the Jasper Park area.

(4) Belt of Precambrian and early Palaeozoic rocks that forms the western part of the Rocky Mountains, partly covered by Banff, Jasper, Yoho and Kootenay Parks, and all of the Purcell and Selkirk Ranges, in which are Glacier and Revelstoke Parks.

(5) Area of Precambrian with erosion remnants of early Palaeozoic rocks that projects northward from the International Boundary east of Flathead River in which is located Waterton Lakes Park. This Precambrian area is bordered on the east, north and west by faults that dip under it and separate it from Upper Cretaceous sediments of the Alberta foothills, and from Lower Cretaceous beds of the Flathead coal basin. Although the sequence and character of its Precambrian rocks are similar to those on the west side of Flathead River at the International Boundary, the Waterton fault-block is here considered by the writer as a separate structural unit. It is believed to represent a south-easterly extension of the western Rocky Mountain land mass (Belt 4) that, with it, was uplifted and thrust eastward over the Palaeozoic rocks of Belt 3, and, at a considerably later date, was again faulted and thrust northward over the earlier folded and faulted Upper Cretaceous sediments of the Crowsnest Pass area and bordering foothills on the east.

Brief though it necessarily is, the foregoing geological description of the park region as a whole should help towards a clearer understanding, from what now follows, of how the individual national parks resemble or differ from one another in their main geological features.

National Mountain Parks

Banff National Park

Banff, the oldest of the national parks, was created in 1885 as a health and recreational resort in the vicinity of the then newly-discovered hot springs at Banff which were found to possess medicinal properties. From its original small area of ten square miles, the size of the park has grown steadily, along with its popularity, and at present it embraces an area of 2,585 square miles of the east slope of the Rockies, possessing mountain and glacial scenery that surpasses in grandeur that of the European Alps.

The Continental Divide forms its western boundary from Mount Sir Douglas on the south to Snow Dome on the north, a distance of 210 miles. Within the park there is a difference of elevation or a relief of 7,500 feet, the lowest elevation, 4,362 feet, being on Bow River at the eastern entrance to the park, and the highest summit being that of Mount Assiniboine, the Matterhorn of the Rockies, with an elevation of 11,870 feet.

The main artery of travel through the park is the broad valley of the Bow River which is traversed by both the Canadian Pacific Railway and the Government motor highway from the eastern entrance to near Kicking Horse Pass, the main western gateway, where both railway and highway cross the Continental Divide into Yoho Park. In the Bow River Valley, situated 40 miles apart in two entirely different settings of mountain architecture, are the beautiful resorts of Banff and Lake Louise, and from these and other centres, roads and trails lead up the valleys and ridges into the surrounding mountain wilderness. (Photo 3). From the main motor route the Banff-Windermere Highway runs westerly, crossing the Continental Divide at Vermilion Pass into Kootenay Park, and the Banff-Jasper Highway runs north-westerly, crossing Bow

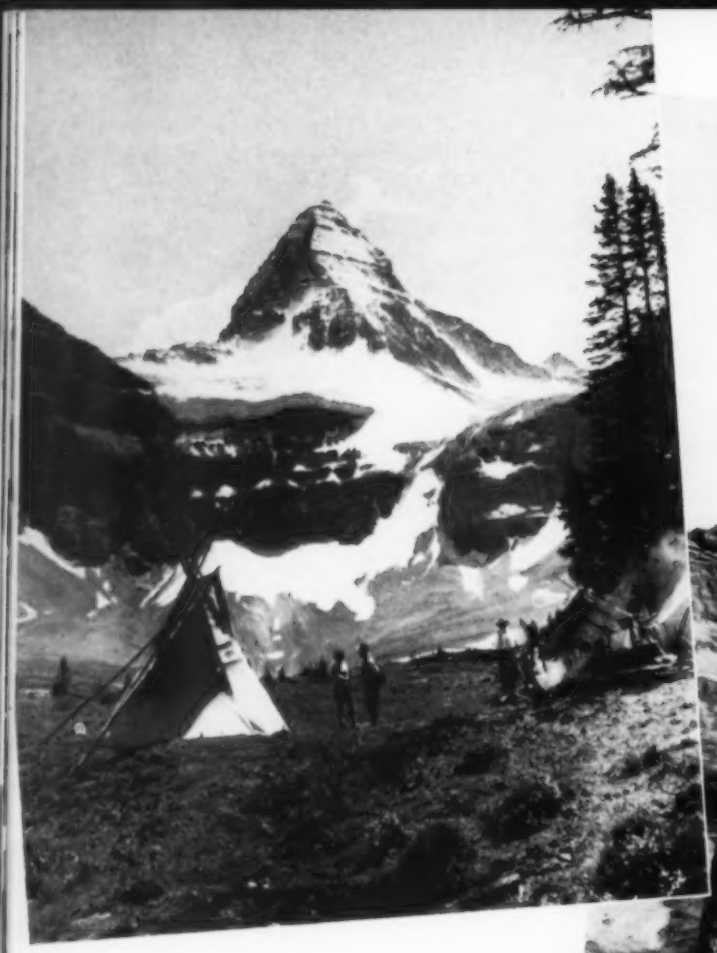
Pass and across the basin of the North Saskatchewan River, and through Sunwapta Pass into Jasper Park.

In few parks is it possible to view to better advantage Nature's handiwork in a great variety of forms, and to see her actually engaged in her work of creation. The great processes of mountain building and evidences of the mighty forces of Nature are revealed in all their grandeur, challenging both the skill and daring of the mountaineer and the imagination of the geologist. Within the park are three types of mountain structure. The eastern belt, sixteen miles wide, consists of a series of three westerly-tilted fault-block ranges of Palaeozoic and Mesozoic rocks, e.g., Palliser Range, Cascade Range, (Rundle Mountain), and Sulphur Mountain Range. Each of these ranges is characterized by a gently dipping west slope conforming to the general south-westerly dip of the rock formations, and a steep eastern face that is governed largely by jointing vertical to the bedding. The Palliser fault-block is ten miles in width and extends a short distance east of the park boundary where normally deep-lying Devonian strata may be observed to overlie much younger Upper Cretaceous strata of the Alberta foothills. (Photo 1). The Cascade fault-block is three and a half miles wide, and its still older Devonian strata override Lower Cretaceous beds of the Cascade coal basin. The Sulphur Mountain fault-block is two and a half miles in width, and its basal Devonian limestone, in turn, overlies much younger Triassic shales of the Cascade Range. It is on or close to this fault that the Banff Hot Springs, five in number, are located.

The second type of mountain structure is that represented by Sawback Range, five miles west of Banff. It occupies a fault-block, three and a half miles wide, of Carboniferous and Devonian rocks that have been folded into a tightly compressed anticline. (Photo 2). The steep dipping beds of this fold form smooth, high, precipitous cliffs and weather into cock's-comb ridges and needle-shaped peaks as Mount Edith and Mount Ishbel.

The third type is that which characterizes the belt, seven miles in width, that lies immediately west of Sawback Range. The mountains here are carved out of flat-lying or gently folded rocks of Carboniferous and Devonian ages and have bee-hive or wedge-shaped summits, hard limestone forming precipitous cliffs and the softer shales gradual slopes, e.g., Pilot Mountain. (Photo 4). This belt is bounded on the west by a major longitudinal fault which crosses Bow River Valley at Johnston Canyon and Brewster Creek and along which a block of Cambrian and Precambrian rocks has been thrust upward and eastward over rocks of Devonian age. Immediately west of this fault is a belt, three and a half miles wide, which is underlain by Precambrian rocks, the oldest exposed rocks in the central Rockies, and the remainder of the park area is underlain by Cambrian rocks. In this wide belt of Precambrian and Cambrian rocks that forms the greater part of the park, mountains of three types occur, but they exhibit a variety of profiles due to the pronounced vertical jointing and greater resistance to weathering of the quartzite formations that compose them, and the more intense

Pilot Mountain — a mountain carved out of flat-lying beds of different hardnesses; the hard quartzite and limestone beds form the precipitous cliffs and the softer shale beds the gradual slopes, giving the mountain a bee-hive outline. (Photo 4).



Top left:—Mount Assiniboine — a high sharp-cut pyramid-shaped peak or Matterhorn on the Continental Divide, elevation 11,870, and bordering cirques formed by alpine glaciation. (Photo 5).

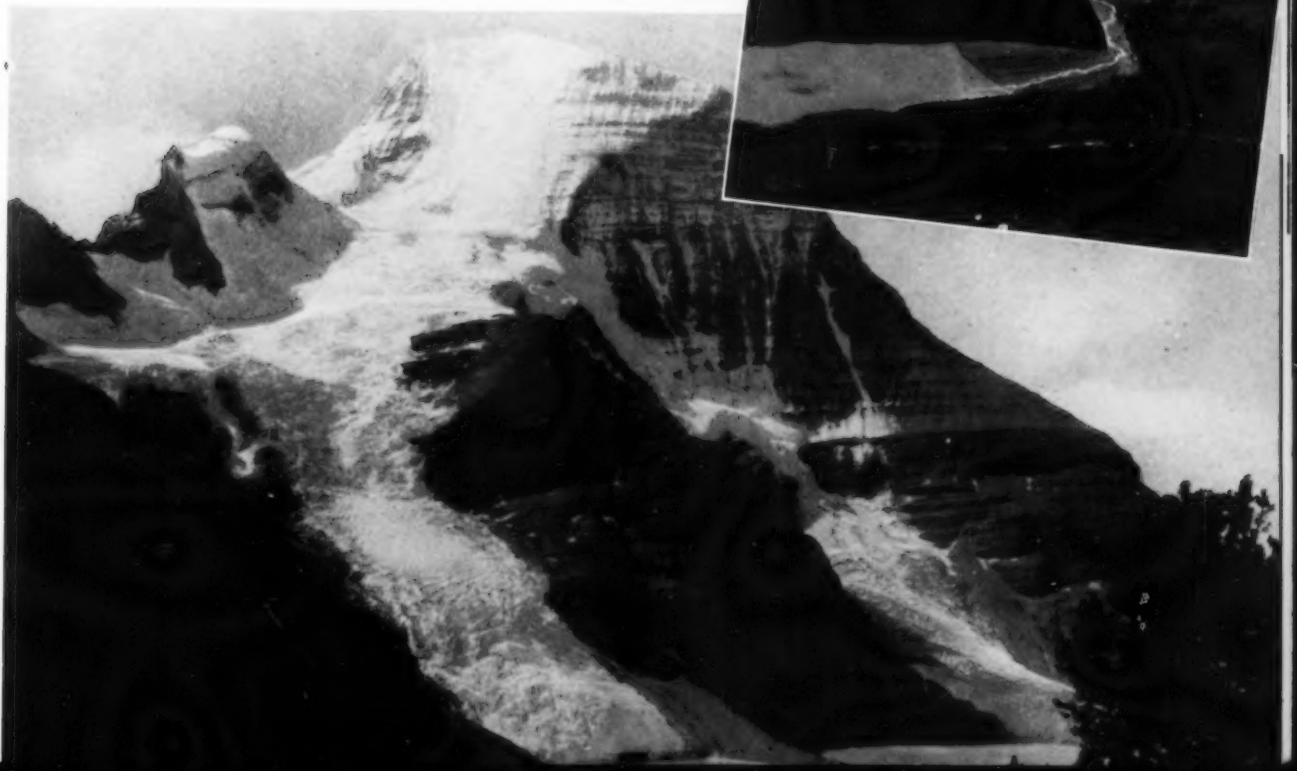
Above:—Craggy cliffs or "gendarmes" on the east side of Eiffel Peak formed by jointing of Middle Cambrian limestone. Far beneath is to be seen Moraine Lake, and the upper part of the large glacial amphitheatre or cirque. (Photo 6).

Left:—View looking south-west along the trail at Lake Louise, showing Victoria Glacier (centre), Mount Lefroy (left), and Mount Victoria (right background). (Photo 7).

Above:—View of Columbia Ice-field from upper part of Saskatchewan Glacier with Mount Athabaska, 11,452 feet elevation, in the right background. (Photo 9).

Right:—View looking south-west across Hector Lake and delta toward Mount Balfour, 10,741 feet elevation, on Continental Divide, and Balfour Glacier with moraines. (Photo 8.)

Below:—View from near Jasper Park boundary looking south-west across Berg Lake, 5,417 feet elevation, and Berg Glacier to Mount Robson, the highest peak in the Canadian Rockies, 12,972 feet elevation. On the cliff is exposed a section of over 7,500 feet of flat-lying Cambrian strata. (Photo 10).



glacial sculpturing to which they have been subjected.

The work of mountain glaciers, the last great land sculptors, is especially pronounced within the park area. At its northern end, the park shares with Jasper Park the great Columbia Ice-field, a remnant of the Ice Age, 150 square miles in extent, which straddles the Continental Divide, and sends tongues of ice down a dozen valleys, the waters of which drain into three oceans, the Pacific, the Arctic, and through Hudson Bay into the Atlantic. Saskatchewan Glacier (Photo 9) is the largest of these tongues.

Along the entire western part of the park and over most of its northern area are scores of cliff and valley glaciers with crevassed surfaces streaked with morainic debris and bordered by an infinitude of glacial-sculptured landforms in all stages of development. They include most of the high pyramid-shaped peaks along the Continental Divide, e.g., Mount Assiniboine, Pinnacle Mountain, Pharoah Peaks, and Mount Balfour; knife-edged ridges as Castle Mountain; hundreds of cirques with high vertical walls and beautiful rock-basin lakes, one of which, Lake Louise, is widely recognized as one of the most beautiful mountain tarns in the world; numerous U-shaped valleys bordered by glacial-smoothed walls, truncated mountain spurs and hanging valleys; and giant waterfalls. (Photos 5, 6, and 7). Many of these valleys contain lakes, such as Moraine Lake, that have been formed partly by glacial gouging and partly by the deposition of rock debris by the glacier at the termination of the ice tongue or where it halted in its retreat. In many of these lakes, (e.g. Hector Lake), large deltas are built by sand brought down by the stream issuing from the glaciers. (Photo 8).

At lower altitudes the deposition of glacial debris in some of the valleys has caused a diversion of the drainage to other stream channels. This is apparent at Tunnel Mountain, opposite Banff Springs Hotel (Photo 3), where Bow River abandoned its pre-glacial channel and turned southward into the valley of Spray River; the erosion of this channel forming Bow Falls. In some places, as for example three miles east of Banff, the stream has cut its channel deep into the boulder clay, exposing sections of the glacial drift over 200 feet thick, and rain-water has cut the hard cemented boulder clay into fantastic forms called "hoodoos".

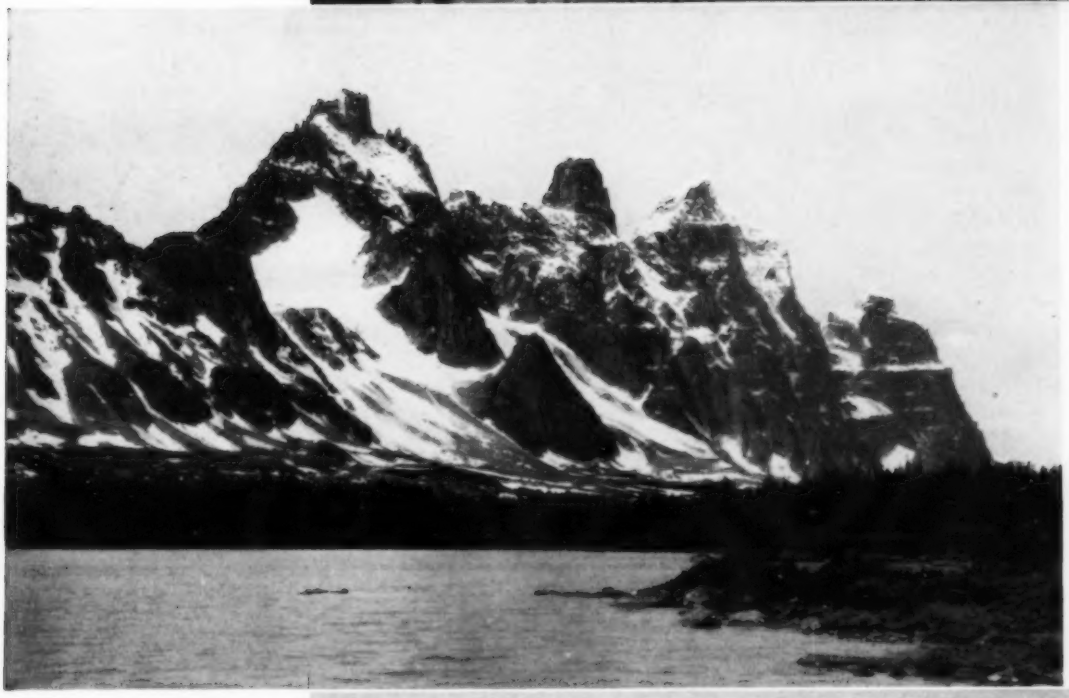
One of the most scenic topographic features in Banff Park is Lake Minnewanka, eight miles east of the Town of Banff. The lake is twelve miles in length, over half a mile wide, and in places over 300 feet deep. It occupies a U-shaped valley with high precipitous walls which continues eastward through Palliser Range as Devil's Gap where it opens into Ghost River Valley. The valley is a former course of the Bow River and although it has been widened and deepened by glacial erosion, the diversion of Bow River south down Cascade Valley is believed to have taken place during the last mountain uplift, long before the Glacial Period.

Jasper National Park

Jasper National Park, the largest national park in North America, was established in 1907, and has an area of 4,200 square miles, much of which is still an unexplored mountain wilderness. The park extends approximately 75 miles north-west and south-east of the broad, flat-bottomed valley of Athabaska River, and its tributary, Miette River. These valleys form the main route of travel through the park, being followed by the Canadian National Railway which crosses the Continental Divide at Yellowhead Pass at an elevation of 3,711 feet. This is the lowest pass across the Rockies on the continent. The divide forms the western border of the park for 220 miles. Within the park there is a total difference in elevation of over 9,000 feet; the lowest point being on Athabaska River at the eastern entrance of the park, 3,232 feet, and the highest peak, Mount Columbia, 12,294 feet. Mount Robson, the highest peak in the Canadian Rockies, 12,972 feet, is five miles west of the Continental Divide. The little Town of Jasper, the park administrative centre, and the celebrated Jasper Park Lodge are situated near the centre of the park, three miles apart, on opposite sides of the Athabaska River immediately below the confluence of Miette River. They are surrounded by majestic snow-clad mountain peaks and attendant glaciers lying a mile or more above them.

As Jasper Park lies in the same mountain belt as Banff, a similarity in their geological features is to be expected. This similarity extends even to such peculiar phenomena as the presence in Jasper Park of a group of hot springs of medicinal value, and earth pillars or "hoodoos" similar to those at Banff. Practically every feature of geological interest of Banff Park has

Roche à Perdrix, the north end of Fiddle Range near the east entrance of Jasper Park, a tightly folded anticline in Devonian limestone. (Photo 11.)



The Ramparts and Tonquin Valley near the Continental Divide whose castellated peaks have been carved by ice out of flat-lying quartzites of Cambrian age. (Photo 12).

View looking south across Cavell Lake to Mount Edith Cavell, 11,033 feet elevation, showing a portion of one of the wings of Angel Glacier. (Photo 13).

its counterpart somewhere in Jasper Park, but, just as the performance of a full orchestra differs from chamber music, so in Jasper the development of most of the geological features is on a much more colossal scale than in Banff. (Photo 10).

There is both a similarity and a diversity with respect to the mountain structure. In the eastern part of Jasper Park the mountains are carved out of Palaeozoic and Mesozoic rocks that appear to have been more highly folded than those of Banff before being broken into large fault-blocks and thrust over one another to the east. Roche à Perdrix (Fiddle Range) is a tightly squeezed anticline, and erosion remnants of folds are to be seen on the tilted fault-blocks to the west as Roche Miette (the summit of Miette Range), and on Rocky River. (Photo 11).

West of Rocky-Snake Indian Valley is a belt, ten miles wide, in which the ranges are carved out of steeply-dipping and, in places, tightly-folded beds of early Mesozoic and Palaeozoic rocks, and are characterized by smooth precipitous cliffs and castellated peaks such as those of Jacques and De Smet Ranges.

Farther west is a fault-block, three and a half miles in width, of gentle, westerly-dipping Palaeozoic sediments in which mountains, as the Palisade, have a steep joint-controlled east face and a gentle westerly slope. The mountains in the western sixteen-mile-wide belt of the park are cut out of flat-lying to gently-folded Cambrian and Precambrian rocks, and have the characteristic pyramid-shaped and bee-hive-shaped summits as shown in Pyramid Mountain, six miles north of Jasper, Mount Athabaska and the Ramparts of Tonquin Valley, and Mount Columbia on the Continental Divide. (Photo 12).

Jasper Park shares with Banff the great Columbia Ice-field which covers an area of 150 square miles, much of which is above 10,000 feet in elevation. From it many glaciers reach far down the bordering valleys to elevations of about 6,000 feet; two of these, Scott and Athabaska Glaciers, are the most spectacular, being characterized by large crevasses, cascades, water channels, rock tables and moraines. (See photo "Roof of the Continent", page 74). Many of the glaciers end in rock-basin lakes, but in most the ice tongue is a considerable distance back from the lake and bears evidence of recent retreat by the abandoned moraines, some of which are nearly a quarter of a mile distant from the end of the ice tongue. All these features may be observed on Angel Glacier on the north slope of Mount Edith Cavell, reached by one of the most popular scenic motor routes from Jasper. (Photo 13).

The valley of Maligne River is full of interest to the ordinary tourist as well as the physical geographer. It is cut in limestone of Devonian age and its upper part has been deepened and widened into a U-shaped cross-section by a large valley glacier. In it are two large lakes; Maligne Lake, fourteen miles long and one-quarter to two miles wide, lies near the head of the valley, and Medicine Lake, four miles long and one-half mile wide, occurs eight miles down-stream. (Photo 14). The outflow of Medicine Lake is through a subterranean channel. A considerable part of this underground drainage emerges a short distance below the lake and becomes Maligne River. Nine miles below the lake this river has carved out a gorge known as Maligne Canyon, which is several hundred feet deep and has vertical walls in places only a few feet apart. The cutting of this canyon began at the close of the Glacial Period, and was caused by the river being diverted from its preglacial channel by the deposition of glacial drift and thus forced to follow a new course which led over the rock wall of the Athabaska River. This resulted in a waterfall and the development of pot-holes by the churning action of large boulders carried by the stream. During the succeeding centuries pot-hole after pot-hole was formed, enlarged, and cut away, and the waterfall migrated slowly up-stream, leaving behind the deep gorge. In the bottom of this gorge, about a mile from the Athabaska River, a large stream enters on the west side, and is believed to be the outlet of a subterranean channel from Medicine Lake. (Photo 15).

Along Medicine Lake Highway are thick deposits of glacial drift or boulder clay which in places have been cut into high fantastic earth pillars called "hoodoos" or "demoiselles", similar to those at Banff. The Miette Hot Springs, occurring on Sulphur Creek in Miette Range, are one of the popular resorts in the park and are easily reached by motor from Jasper.

Waterton Lakes National Park

Waterton Lakes National Park covers 220 square miles on the east side of the Continental Divide at the International Boundary, and adjoins Glacier National Park in the United States. Most of the park area consists of rugged mountain territory that rises abruptly several thou-

Above:—Looking up Maligne Canyon, a narrow gorge hundreds of feet deep cut in Devonian limestone. (Photo 15).

Top right:—View looking north-west along the glacier-gouged valley of Maligne Lake through Sampson Narrows to beyond Sampson and Leah Peaks, carved from Devonian rocks. (Photo 14).

Right:—Hikers viewing townsite of Waterton Park built on delta in Waterton Lake from shoulder of Crandall Mountain, showing cliffs of folded Precambrian formations on Vimy Ridge (left) and Mount Boswell (extreme right). (Photo 16).

Left: — Looking south along glacier-gouged valley of Upper Waterton Lake, cut in Precambrian rocks. (Photo 17).

sand feet above the bordering foothills of Alberta, from which it is separated by a major fault. This elevated plateau has been deeply dissected by streams and reduced to sharp peaks, narrow ridges and intervening deep valleys. The highest peak in the park is Mount Blakiston with an elevation of 9,600 feet.

Waterton Lakes Park differs from the other national parks on the east side of the Rocky Mountains in having no formations of Palaeozoic age that constitute the mountain ranges in the eastern Rockies in the Banff and Jasper Parks. An erosion remnant of Silurian rocks occurs overlying Cambrian rocks a little to the north-west of the park area, but if these and younger formations were ever present over the park area, they have been entirely removed by erosion. The mountains within the park are carved wholly out of Precambrian rocks that are among the oldest exposed sediments of the earth's crust. (Photo 16). They have a total exposed thickness in the park of over 13,000 feet, and are identical in character and sequence with those lying on the west side of Flathead River. The Waterton Lakes Precambrian area is bounded on the east, north, and west by faults that dip into it. It is believed to represent the south-easterly extension of the Precambrian land mass to the west that was separated later from it by a fault and thrust, as a separate mountain mass, northward overriding Upper Cretaceous rocks of the Crowsnest Pass and bordering Alberta foothills and Lower Cretaceous rocks of the Flathead coal basin, several hundred millions of years younger in age.

The rocks of Waterton Lakes Park now occur in three broad folds which trend in a north-westerly direction. The central fold is an upward arch or anticline whose axis conforms to the lower part of Cameron Brook. Erosion along the crest of this fold has exposed at Cameron Falls the oldest rocks to be observed anywhere in this part of the Rocky Mountains. To the east and to the west of this anticline are broad troughs or synclines in which occur overlying younger formations. Along the motor road from Waterton Lakes Park townsite west to Cameron Lake one may observe in ascending order almost the complete sequence of 13,000 feet of Precambrian rocks.

Waterton Lakes Park is unique with respect to its superb glacial sculpturing, and although the glaciers have long since disappeared from the area, there are few, if any, regions in the world where the work of former glaciers can be observed to better advantage. One of the outstanding features in the park is Waterton Lake, eight miles in length, one-half mile in width, and in places over 400 feet deep. (Photo 17). It occupies a fault trench separating Lewis and Clarke Ranges, that has been considerably deepened and widened by a valley glacier. At Cameron Falls, Cameron Brook cascades from its hanging valley with a drop of about 200 feet to the level of Waterton Lake.

In the higher regions are numerous landforms sculptured by alpine glaciers. They include such pyramid-shaped peaks as Mount Alderson, Mount Carthew, Mount Lineham and Sofa Mountain; arêtes, and numerous large cirques, many of which contain beautiful lakes, such as Cameron Lake, Bertha Lake, Alderson Lake, Crypt Lake, Lineham Lake, Carthew Lake, Rowe Lakes, and Twin Lakes. On the uplands the quarrying effect of the frost and ice action, and channels formed in the rock by snow water, are much in evidence. (Photo 18).

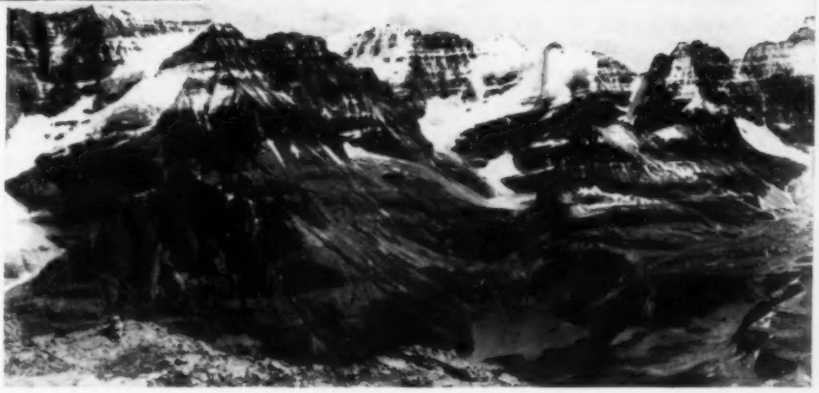
Yoho National Park

Yoho National Park covers 507 square miles of the western or British Columbia slope of the Rocky Mountains. The Continental Divide, which forms the common boundary between Yoho and Banff Parks for a distance of thirty miles, is purely an erosional height of land, with the same rock formations and the same open mountain folds occurring on its opposite sides. The differences that exist between Yoho Park and the western part of Banff Park are largely due to the greater annual precipitation on the west slope of the Continental Divide and the greater denudation resulting from a lower base level. Most of the Yoho Park area lies within the drainage basin of Kicking Horse River which rises near Kicking Horse Pass, elevation 5,359 feet, traverses the park area for a distance of twenty-three miles, and crosses its western border at an elevation of 3,300 feet. (Photo 19). This river valley is the main artery of travel in the park and is followed by the Canadian Pacific Railway and the Government motor highway. Near Yoho Valley the railway gradient was so steep that it was found necessary to reduce it by the driving of a double loop switchback and two rock tunnels on the opposite sides of Kicking Horse River Valley. As Mount Hungabee, situated on the Continental Divide eight miles south of the Pass, has an

Above:—A natural tunnel cut in the cliff of Precambrian quartzites at the head of Hell-Roaring Creek. Through this tunnel passes the trail to Crypt Lake. (Photo 18).

Top left:—Looking north-east up Kicking Horse River Valley with the Town of Field and Mount Stephen on the right and Mount Field on the left. On the slopes of these mountains in beds of Middle Cambrian age occur a wealth of fossils that have made the localities famous. (Photo 19).

Left:—Spike Mountain, a sharp-cut, pyramid-shaped peak or Matterhorn on Van Horne Range formed by alpine glaciation in steeply-dipping beds. (Photo 21).



Right: — Looking east from Mount Odaray to Mount Victoria (left), Mount Lefroy (centre), and Mount Hungabee (extreme right), with Lake O'Hara (lower foreground) and Lake Oesa (above) showing cliffs, steps, reversed valley slopes and other features formed by the sapping action of glaciers. (Photo 20).

elevation of 11,457 feet, there is total relief within the park area of 8,157 feet. (Photo 20).

The rocks from which the mountains have been carved consist of sandstone, shale and limestone of Lower, Middle, and Upper Cambrian ages. They have a total exposed thickness within the park of almost three miles and have been bowed into a series of north-westerly trending folds. The central fold is a broad anticline capped by Middle Cambrian rocks whose faulted crest lies between Mount Stephen and Cathedral Mountain. On the east of it is a shallow synclinal basin formed of the same rocks with its centre passing through Mount Niblock close to the Continental Divide. On the west is a much broader syncline whose centre crosses Kicking Horse River five miles south-west of Field. This basin, for a width of twelve miles, is underlain by Upper Cambrian shales, which, being much softer than the underlying quartzite formations, form areas of considerably lower relief. The beds on the eastern limb of this basin have a gentle westerly dip, but those on the western rim, which conforms with Van Horne Range, are steeply inclined and in places even vertical, being underlaid by Middle Cambrian rocks which, on the west, are in faulted contact with a much younger Ordovician shale that underlies a belt four miles in width.

Extensive ice-fields cover much of the Waputik Mountains and send many large glaciers far down the bordering valleys. Much of the summit area of President Range, Van Horne Range, and Ottertail Range are ornamented by cliff glaciers, and the work of former glaciers is evidenced by the myriad of glacial sculptured landforms for which the park is celebrated. They include high pyramid-shaped peaks or horns, e.g., Spike Mountain, ice-carved passes or cols, large cirques, rock-basin lakes, knife-edged ridges or arêtes, U-shaped valleys, hanging valleys, and waterfalls. (Photo 21). At Takakkaw Falls in Yoho Valley the water has a precipitous drop of 1,200 feet and there are many other large falls in the valley such as Twin Falls and Laughing Falls that owe their origin to deepening by valley glaciers. (Photo 22).

In Hoodoo Valley opposite Leanchoil rain-water has cut the cemented boulder clay into fantastic forms called "hoodoos" or "demoiselles" similar to those in Banff and Jasper Parks. (Photo 23).

Kootenay National Park

Kootenay National Park was established to preserve the landscape along the 60-mile section of the Banff-Windermere Highway between Vermilion Pass on the Continental Divide and Radium in the Columbia River Valley. The park covers a belt, ten miles wide, centred along the highway, and embraces 587 square miles of beautiful mountain territory. The highway spans the western slope of the Rocky Mountains, the ranges being crossed by means of three major transverse valleys spaced seventeen miles apart and connecting the three major longitudinal valleys occupied by Vermilion, Kootenay, and Columbia Rivers. The northern and central transverse valleys are occupied by Vermilion River and the southern valley by Swede Creek, flowing east into Kootenay River, and Sinclair Creek flowing west into the Rocky Mountain Trench occupied by Columbia River. (See map).

Along the highway may be observed a sequence of rock formations ranging from Lower Cambrian to Middle Devonian in age with folds and faults that trend in a north-westerly-south-easterly direction paralleling the master longitudinal valleys.

One of the most pronounced faults is that which crosses Vermilion River and Highway four and one-half miles west of Vermilion Pass and which conforms to the valley of Tokumm and Haffner Creeks. This fault, which has a vertical displacement of several thousand feet, brings Lower Cambrian beds on the east in contact with Upper Cambrian beds on the west. Erosion along the fault has cut Marble Canyon, which in places is over two hundred feet deep. (Photo 24).

In the area between this fault and Vermilion Pass are to be observed flat-lying to gently-folded Lower Cambrian shales and limestone occupying the valley bottom, Middle Cambrian limestone forming the mountain slopes, and hard Upper Cambrian limestone and shale capping the summits. The area between the fault and Vermilion Range on the west is underlaid by Upper Cambrian rocks bowed into a broad syncline, the axis of which conforms closely with the longitudinal segment of Vermilion River. The western rim of this Upper Cambrian basin lies in faulted contact with more highly folded shales of Upper Cambrian and Ordovician age that underlie the broad valley of Kootenay River and the east slope of Brisco Range.[5] The crest of Brisco Range

Right:—Marble Canyon — a gorge 200 feet or more deep formed by erosion along a fault that brings Lower Cambrian limestone in contact with Upper Cambrian quartzite. (Photo 24).

Above:—Takakkaw Falls and hanging valley formed by the erosion of a glacier that once occupied Yoho Valley. The stream is fed by the melting of Daly Glacier that issues from Waputik ice-field and has a drop of over 1,200 feet. (Photo 22).

Below:—Earth pillars, "hoodoos" or "demoiselles" in Hoodoo Valley opposite Leanchoil in Kicking Horse River Valley. These fantastic forms have been cut by rain-water from the firmly cemented boulder clay and gravels, the earth pillar being protected by a capping boulder. The inclination of the capping boulders indicates the original surface slope of the boulder clay deposit. (Photo 23).

Above: — Looking from Mount Revelstoke Highway west over the Town of Revelstoke and the Columbia River Valley, "Selkirk Trench" to the Columbia Range, with Mount Begbie (left) and Mount McPherson (right). (Photo 34—See page 95).

Above:—Sinclair Canyon formed by erosion of Sinclair Creek along a transverse fault that crosses Brisco Range. (Photo 25).

Top right:—Looking south-west from Purcell Range across Beaver River Valley (Purcell Trench) over the west slope of Selkirk Range with Deville Glacier at extreme right. (Photo 26).

Above:—Sir Donald Range, summit of Selkirk Mountains, viewed from the south-west showing a variety of landforms sculptured by alpine glaciers, including sharp pyramid-shaped peaks as Eagle Peak (left), Uto Peak (centre) and Mount Sir Donald (right) with intervening passes or "cols". Illecillewaet Glacier lies in the foreground. (Photo 28).

Left: — Mount Macdonald, 9,492 feet elevation, which is penetrated by the five-mile double-tracked Connaught Tunnel lying 5,633 feet vertically beneath the summit. (Photo 27).

and the belt, seven miles wide, between it and Columbia River are characterized by tightly folded, crumpled and faulted rocks most of which are of Ordovician and Silurian ages, but one of the fault-blocks cut by Sinclair Creek reveals at its eastern base Cambrian limestone, and at its western end, a small outcrop of Middle Devonian limestone. It is on one of these faults that the famous Radium Hot Springs are located. The deep canyon cut by Sinclair Creek along a transverse fault or joint plane in steeply dipping rocks forms one of the most scenic sections of the motor highway. (Photo 25).

The summit areas of the Continental Divide and of Vermilion Range, which form the eastern and western boundaries of the park in its northern part, are covered with large glaciers and snowfields above which tower high sharp-cut pyramid-shaped peaks. The highway and trails make it possible for both the alpine climber and the tourist to find easy access to these delightful regions.

Glacier National Park

Glacier National Park, so-named from the profusion of ice-fields and glaciers in it, is an area of unrivalled alpine beauty. It spans the summit of the Selkirks, the Purcell Trench, and the western slope of the Purcell Range. The park, embracing 521 square miles, is roughly rectangular in outline, measuring twenty-five miles in a north-south direction, and from eighteen to twenty-five miles in an east-west direction. (Photo 26). Glacier, the main railway station, is located near the centre of the park close to the summit of the Selkirks. The Canadian Pacific Railway traverses the park area for a distance of twenty-five miles, entering it by the valley of Beaver River at a point two miles south of Rogers Station and leaving its western border by the Illecillewaet River Valley two miles north-east of the station of that name. The railway formerly climbed over the summit of the Selkirks in Rogers Pass, elevation 4,341 feet, but the ascent has been reduced by 480 feet through the driving of the five-mile, double-tracked Connaught Tunnel through Mount Macdonald at an elevation of 3,860 feet, the summit of the mountain being 5,633 feet vertically above the tunnel. (Photo 27). As the elevations at the north and west entrances of the park are less than 2,900 feet above sea-level, and the highest summit in the park, Hasler Peak, is 11,123 feet, there is a vertical relief of over 8,200 feet.

Although the average height of the peaks in the Selkirks and Purcell Ranges is considerably less than that of the Rockies, the profusion of extensive coalescing ice-fields and large bordering glaciers contrasted with the sharp mountain peaks and serrated ridges that rise far above the snow, and the dark green luxuriant forest of the lower mountain slopes, combine in giving to this park an exceptional charm and beauty. In the eastern part of the park, for a distance of twenty-five miles, is the valley, four miles in width, occupied by Beaver River, and known as the Purcell Trench. This valley runs with remarkable straightness in a southerly direction into the United States and is one of the major topographic features of the Cordilleran Belt.

Rocks of Glacier National Park are of Cambrian and Precambrian ages and have a total exposed thickness of more than eight miles. They are folded into a series of anticlines and synclines that trend in a northerly direction roughly paralleling the course of Beaver River. On the east is a broad anticline of Precambrian rocks, along the faulted crest of which runs Beaver River. On the west is a large synclinal basin, the axis of which crosses the railway a little east of Glacier Station. This basin is occupied over a width of three and one-half miles by the youngest formation in the park area, quartzites of Lower Cambrian age. Between Glacier and the western border of the park the rocks have a general north-easterly dip forming the western flank of the basin. In the intervening area between Rogers Pass and the crest of the Selkirks are two minor folds in Lower Cambrian quartzites; it is in these folds that Mount Sir Donald and Mount Tupper are located. (Photo 28). Several minor folds also occur on the west slope of Purcell Range in that part of the park between Beaver River and its eastern border. (Photo 29).

Most of the rock formations within the park area are of quartzite, but there is a 350-600-foot thick crystalline limestone formation, called Nakimu limestone, which is of special interest. This formation, where exposed on Cougar Creek, four miles west of Glacier, is characterized by large caves, known as the "Caves of Nakimu" or the "Caves of Cheops", that have been formed by solution and mechanical erosion of Cougar Creek in a subterranean part of its course along the formation. (Photo 30).

Most of the uplands are covered by extensive ice-fields or névé fields, including Illecillewaet Névé, Van Horne Névé, and Bonney Névé, from all of which large glaciers extend for miles down the valleys. (Photo 31). One of these, Illecillewaet Glacier, reaches down the valley to within two miles of Glacier Station. Between and among these glaciers and snowfields are myriads of landforms typical of alpine glaciation.

The western side of Beaver Valley has scores of cirques, most of them occupied by living glaciers, e.g., Grand Glacier, Deville Glacier. (Photo 32). Beaver Valley itself has been considerably deepened and widened by glacial erosion and is bordered by numerous hanging valleys. (Photo 26).

Mount Revelstoke National Park

Mount Revelstoke National Park, which forms the last link westward in Canada's chain of national parks, covers an area of 100 square miles in the north-east angle between the Illecillewaet and Columbia River Valleys. The Town of Revelstoke is built on the alluvial flat bordering the park at an elevation of 1,500 feet, and from the valley bottom the surrounding mountains rise precipitously to rear their snow-capped heads high into the clouds, some reaching elevations of over 10,000 feet. At the summit of Mount Revelstoke is a large snowfield which is bordered by cirques, some of which contain beautiful rock-basin lakes, such as Millar Lake, Jade Lake, and Lake Eva. (Photo 33). An eighteen-mile scenic motor road ascends the mountain slope for more than 4,000 feet by a series of switchbacks from the townsite through a virgin forest of cedar, balsam, and spruce, and ends in a beautiful alpine park near which is Balsam Lake camping-ground.

The view from the uplands is awe-inspiring. North and south, as far as the eye can see, extends the broad, flat-bottomed Selkirk Trench occupied by the Columbia River and Upper and Lower Arrow Lakes; on the west rise the snow-capped peaks of Columbia Range, which culminate in Mount Begbie, ten miles to the south-west, with an elevation of 8,956 feet. (See Photo 34, page 91). Directly east is the long deeply entrenched gorge of Illecillewaet River, and across it to the south-east rise the snow-capped peaks of the Selkirk Range, the nearest of which, Mount Albert, has an elevation of 10,008 feet.

The rocks at Revelstoke Park consist of a complex of ancient sediments that were laid down long before the life record began, and of igneous rocks that were injected into these sedimentary rocks at a much later geological period. Both rocks have been further altered by heat and pressure to which they have been subjected so that in places it is difficult to determine whether the rock is of sedimentary or of volcanic origin.

* * *

Canadians, as well as foreign visitors, have begun to appreciate the splendid mountain scenery and the unsurpassed recreational advantages for rest, sport, and nature study offered by these national mountain parks. Annually, hundreds of thousands are attracted to these glorious alpine regions to enjoy a delightful holiday and gain new health and vigour. It is not accidental that much of the exploration of the Canadian Rockies and Selkirks has been done by British and Continental Europeans who received their training as mountaineers in the Alps, and that many annually travel thousands of miles to our western mountains when the Alps are so much more accessible. It is significant also that the membership of the Alpine Club of Canada includes, in addition to Europeans, many residents of the Eastern United States who prefer climbing in the Canadian Rockies and Selkirks, notwithstanding the fact that the Rocky Mountains in the United States rise to higher elevations. The reason for this is that the Canadian mountains offer not only the lure and adventure which a vast unexplored wilderness with unscaled summits affords, but possess a charm in extensive ice-fields, glistening glaciers and snow-clad peaks, the like of which can be seen neither in Switzerland nor in the United States. Moreover, they offer opportunities for climbing with a wide range in difficulty and diversity rarely obtainable elsewhere.

A most important factor in increasing the popularity and use of these national playgrounds by the general public has been the construction of numerous trails and the linking up of the parks by motor highways as shown on the accompanying map. The latest of these highways to be completed is the 186-mile motor highway joining the administrative centres of Banff and Jasper. Traversing as it does the very heart of the Rocky Mountains and skirting the great Columbia Ice-field that caps the "Roof of the Continent", it offers an added inducement to new thousands of tourists to view the scenic splendour of Canada's alpine wonderland.

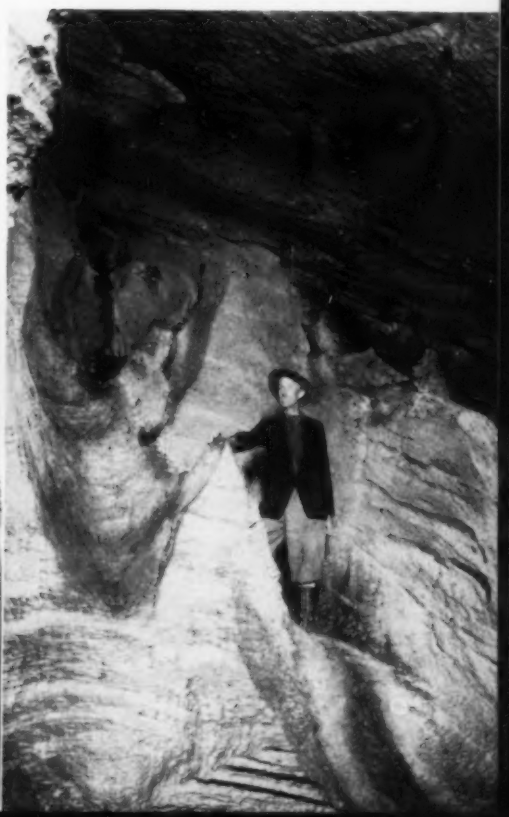
Right: — High cliffs of jointed quartzite of Cambrian age characterize the top of Mount Tupper on north side of Rogers Pass, Selkirk Range. (Photo 29).

Below: — Geikie Glacier issues from Illecillewaet Névé and cascades down the west slope of the Selkirk Range into the head of Incomappleux River Valley. (Photo 31).

Centre left:—The Grand Glacier extends down the east slope of the Selkirk Range into Beaver Valley. It is characterized by moraines, cascades, crevasses and bordered on the upland by serrated ridges and circues. (Photo 32).

Bottom left:—Lake Millar, a rock-basin lake formed by alpine glaciation on the slope of Mount Revelstoke. (Photo 33).

Below:—The Witches Ballroom, Nakimu Caves, one of a series of large chambers cut by Cougar Creek in a subterranean part of its course in the Nakimu limestone formation. (Photo 30).



A powerful denizen of frozen trails.

Photo by Wallace W. Kirkland, Chicago.

Lord of the snowy highways of the Far North, enjoying a well-earned rest with the coming of the brief boreal summer.

Courtesy Hudson's Bay Company.

ESKIMO DOGS OF THE CANADIAN ARCTIC

by J. DEWEY SOPER

IN the Arctic regions the Eskimo dog (*Canis familiaris borealis* Dism.) functions in the same relative manner as do the horse and motor-car of more southerly communities. To the Eskimos the dog is absolutely indispensable. The mode of life thrust upon these people in their fight to wrest a bare subsistence from hard circumstance, calls for the aid of their dogs at nearly every turn. Especially is this true for the eight or nine months' period of possible sledge travel in each year. During this time the sledge dogs are almost perpetually in harness. They provide the only feasible means of travel over land and sea in a region where lack of ready transportation would inevitably spell death.

For both man and dog the first requirement is meat; man must also be clothed and provided with other essentials such as fuel for heat and light. Meat and clothing come from caribou, seal, walrus and white whale. These animals are obtained by hunting over tundra and at floe-edge with a tireless persistence that beggars description. The importance of social intercourse, moreover, cannot be forgotten, and families, tribal groups and villages are ordinarily far apart. All of these things necessary to the Eskimos are, therefore, obtainable in the last analysis only by means of the Eskimo dog.

White men resident in the Far North have many necessities in common with the Eskimos. This becomes immediately apparent when, aside from ordinary headquarters' routine, they take to the serious and strenuous activities of the open. Here again, the dog is a primary requirement.

Immature sledge dogs of the Far North. With the coming of winter they will fall heir to harness and months of strenuous activity. Photo by Wallace W. Kirkland, Chicago.

As things are, one is effectually anchored without him in meeting the problems of successful accomplishment in exploration and in nearly all other fields of scientific enquiry.

Despite the increasing use of the aeroplane in the Arctic regions, one may be well assured that the dog-team will long remain a fundamental necessity. Flying is yet confined to special localities and purposes and enormous areas have, to date, not been examined by this method and are not likely to be for a long time to come. Even where regular well-spaced landings are possible, there still remains the need for more detailed investigations on the ground. At present, Eskimo dogs and sledges furnish the only means of meeting the varied conditions of polar travel and research. In the history of Arctic exploration the Eskimo dog has deservedly won unqualified tributes to his sagacity, loyalty, and powers of endurance. In dangerous journeys over trackless hinterland he has repeatedly compelled success where man without him would have been impotent. What he did yesterday, he will do to-day and again to-morrow.

Like their masters, these sledge dogs are now generally thought to have had an Asiatic origin, and to have been brought to North America by the Eskimos, later to spread with them across the mainland of Arctic Alaska and Canada, and over much of the polar archipelago to Greenland. Large areas formerly inhabited by ancient tribes are now deserted. Some of the most notable of these include Devon and Ellesmere Islands, where old igloo remains have been discovered embracing cultures reckoned to have an age of at least one thousand years. To-day, distribution is fairly general along the coasts of Greenland, Baffin Island, Labrador and Northern Quebec, Southampton Island, the Arctic Coasts of the Districts of Keewatin and Mackenzie, and adjacent islands, and those of Alaska to Bering Strait.

Generally believed to have descended from the wolf, the Eskimo dog doubtless springs from a past of considerable antiquity, for viewed in terms of the present-day struggle for existence, it is difficult to visualize a time in which the Eskimos, leading such an exacting and specialized life, found it possible to cope with the conditions

of a polar environment without their aid. They were almost certainly evolved from a wild stock at an early date. At the present time the Eskimo dog is universally employed by the various tribes over the whole of the vast hinterland indicated above. It is known by such names as "husky" and "wolf dog", though in the Eastern Canadian Arctic it is customarily referred to simply as the "Eskimo dog", or by the native name, "Kingmik".

The true home of the Eskimo dog is in the polar regions. It is characterized by level tundra plain, or desolate mountainous country, normally destitute of trees of any kind, though often relieved by scrubby bushes of birch and willow a few inches high. Nearly everywhere the rocks and scanty soil are carpeted with a thin covering of lichens, various mosses, and during the brief summer, diminutive flowering plants.

The latter season may be said to last from late June or early July, until mid-, or late August, when signs of autumn steal upon the land. Winter usually prevails from late September until the following May. The Arctic climate is typified by violent contrasts of heat and cold, calm and storm, cloud-rack and sunshine, though much clear, sunny weather prevails. Inhabitants face that peculiarity of the polar regions — the rapid change and notable contrast of seasonal light and shadow as manifested by the phenomena of summer midnight sun and the duskiness, or total darkness, of the depths of winter.

The female Eskimo dog usually gives birth to from six to eight young, and litters may appear at any season of the year. If the mother is left to her own resources at such a time, she normally retires to a wild, secluded place to have her progeny At this time she is usually crabbed and suspicious, and particularly resents the proximity of adult males; on occasion some of the latter are not averse to disposing of the defenceless puppies in the absence of the mother. At birth, the young are comparatively well haired; development of pelage and weight is usually rapid, the rate at times little short of incredible.

In the summer the Eskimos give little heed to the event of birth, but during winter it is a common practice to build

Summer days of rest and freedom at Pond Inlet, northern Baffin Island. Courtesy Hudson's Bay Company.

An Eskimo dog-team in action on the pool-sprinkled sea-ice along the coast east of Lake Harbour, Baffin Island.

little snowhouses especially for the comfort of mother and puppies; the floor is covered with old sacks, moss, or heather to keep the youngsters dry and warm. Especially if dogs are scarce, the Eskimos show marked regard and kindness for the new arrivals, and particularly in the dead of winter, it is not unusual to see female and pups sheltered for a time in the living quarters of the igloo proper, or in the anti-chamber. It appears on good authority that puppies may be born and successfully raised in a wild state directly in the snow, particularly if temperatures and weather are not too severe.

Eskimo children delight in fondling the puppies from the first, and as a result of such handling they grow up gentle and accustomed to human contact; in consequence, they are much more readily broken to harness, travel, and the commands of the driver. So hardy are the young under normal circumstances, that when only a month old they can readily withstand all the rigours of the Arctic winter. Growth is consistent and rapid, unless halted by disease, and before a year old, they have taken their place in the team to serve faithfully as a draught animal until accident, disease, or old age marks the end of the trail.

In some parts of the Far North pure-blooded Eskimo dogs are now rare. This arises from the fact that white men, especially of recent years, have devoted considerable attention to increasing the size and speed of native dogs for draught purposes by cross-breeding with other types. This breeding has often been conducted in an indiscriminate fashion; although in some instances a faster or heavier type has been developed, it is highly problematical if, for general purposes under purely Arctic conditions, any improvement has been achieved.

The Eskimo dog in its evolution from primitive stock is not designed for speed, but he is well supplied with other even more valuable characteristics. From the writer's experience with the pure breed, it would appear to be a physical impossibility to improve upon the strength and stamina displayed by the Eskimo dog in relation to his weight. A further considera-

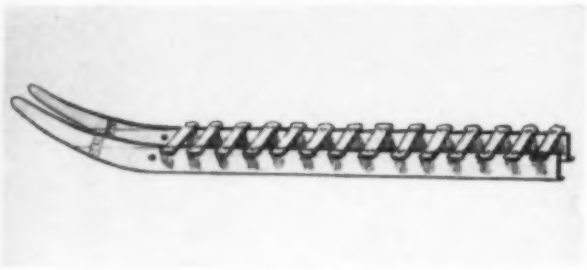
An Eskimo clearing the traces of a "fan" dog-team in the heart of Foxe Peninsula, Baffin Island. Note the long bridle and traces.

tion is the moderate food consumption in relation to this weight and the marvellous powers of endurance inherent in the best of the breed under the most harrowing conditions.

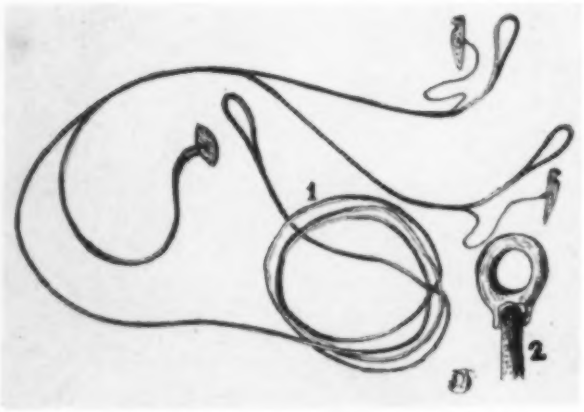
By some, the typical, pure-blooded Eskimo dog is regarded as being of a whitish, or whitish-grey colour. Though it can scarcely be considered as most "typical", it may almost certainly be judged as the most primitive. Present-day dogs, even in isolated and insular districts of the higher latitudes, where the chance of contact with outside strains in early or modern times is extremely remote, still vary greatly in marking and colour from pure creamy white, to black; some are yellow, grey, or brown, while others are bizarrely mottled. Undoubtedly they have been so for many centuries. At any rate, the multi-coloured, mottled native dogs of to-day are common from one end of the Arctic to the other and greatly in the majority.

In Baffin Island the "typical" whitish animal may be regarded almost as a rarity. Very few are encountered in relation to total population. In one case which came to the writer's attention in Foxe Peninsula, the whitish animal was said by the Eskimos to have had a white Arctic wolf as a sire. Promiscuous mating with wolves, according to native assertions, appears to be a more or less regular, though not a frequent, occurrence. The resulting colour would not necessarily be a pure creamy white in the progeny, though that may be dominant, as aside from the biological influence exerted by a multi-coloured female dog; it must be kept in mind that Arctic wolves are not invariably pure creamy white, but are often of darkish grizzled pelage, especially over the dorsal tract.

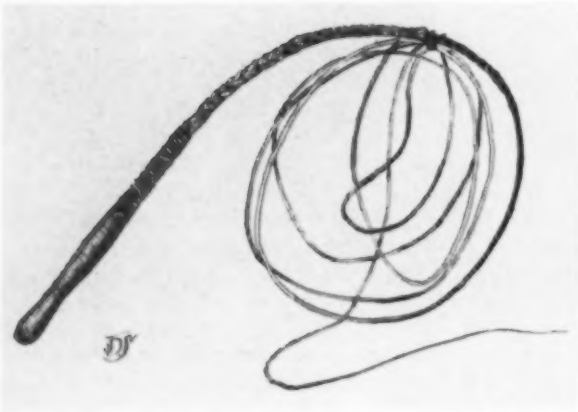
The Eskimo dog of the Eastern Arctic is a sturdy, handsome creature weighing from 50 to 80 pounds. Individual weight varies considerably, depending on age, sex, and other factors. Well-conditioned animals may reach 90 to 100 pounds, or even more. Such are usually fat after a season of ease and plenty and subject to loss of weight with continuous, hard travel. Average height at the shoulder is between 20



The type of sledge used by the Eskimos of Baffin Island; for heavy hauling these vary from 15 to 18 feet in length, pulled usually by 10 to 15 dogs.



1. Bridle for a Baffin Island sledge.
2. End of a dog trace with ivory ring.



A dog whip as used by the Eskimos of Baffin Island. These may vary in length from 15 to 25, or even 30 feet.

and 25 inches. On the whole the animal has a powerful physique, with thick neck and chest, short, strong legs and small, densely-furred feet. During winter the body is thickly clothed with straight hair three or four inches long, with a mane-like growth of somewhat longer hair over the neck and shoulders; below is dense under fur which enables the animal to easily withstand the rigours of high latitudes. The muzzle is tapered, rather short and broad. The thick ears are sharply pointed, while the dark, oblique eyes are characteristically wide-spaced. Typical are white eyebrow spots in the dark fur mask of the face. In a state of health and vigour the thick plume-like tail is held high and acutely curled. As a rule, an indication of sickness, indisposition, or advanced fatigue is displayed by a drooping of the tail.

It is interesting to note the following passage from Peary regarding these animals: "The Eskimo dogs are sturdy, magnificent animals; there may be larger dogs than these, there may be handsomer dogs, other dogs may work as well or travel as fast and far when fully fed, but there is no dog in the world that can work so long in the lowest temperatures on practically nothing to eat . . ."

In general disposition the Eskimo dog is gentle and affectionate; this may be at least partly the result of their up-bringing to which brief reference has already been made. The average individual enjoys attention and in return exhibits such familiar traits as fawning, tail wagging, leg rubbing, and licking the bare hands of their masters. Individuals that are morose, or treacherous are relatively rare. Even with total strangers they are seldom inclined to bite, despite such truculence as may be shown in their attitude; usually they exhibit a rather shy and retiring friendliness and harmless curiosity, or become completely distant. On the whole, the breed is submissive and playful. The oblique eyes, which tend to impart a fierce and deceitful appearance, belie the fundamental disposition.

In this, however, it is true that individual exceptions occur; also that disposition may vary in whole groups as between one section of the country and another. Unlike the Labrador dog, for example, those of Baffin Island, so far as the writer is aware, has never been known to openly attack adults, or kill children. Occasionally a dog goes "loco" and must be killed.

As a rule even little Eskimo children play among swarms of sledge dogs with fearless indifference and impunity.

Among themselves the animals are quarrelsome and brisk fighting ensues at the slightest provocation. This is particularly the case as regards sex and during the distribution of food. At the time of night feeding watchfulness is needed to prevent free-for-all fighting of wolf-like ferocity, injury, and the robbing of the weak by the strong. This is forestalled by a liberal use of the whip. Where females, or food is not involved, the teams are usually well behaved.

There is much that is characteristic of the wolf. Some individuals exhibit a startling similarity to the latter, and in the hills have been so mistaken on more than one occasion. For this reason sled dogs have been shot in error repeatedly. Wolf-like is the tendency to run in packs; the mixture of cowardliness and wild courage; the insatiable love of hunting; and the blood-thirsty ferocity on the occasion of a kill. Furthermore, the Eskimo dog does not bark, but gives vent to a prolonged, wolf-like howling; in chorus with falsetto cries and strangely interwoven tones, this becomes the most weirdly beautiful and thrilling overture of the Arctic lands. It is commonly indulged at night camps, usually initiated, for some unknown reason, by the mournful dirge of a single individual; more and more voices join until a mass crescendo of startling effect rises into the night to persist for varying periods, until as by a signal, absolute silence again abruptly reigns.

In his relation to human beings the Eskimo dog is either confidently affectionate, skulking and cowardly, or both. With encouragement and good behaviour its actions are frank and friendly; none knows better than he, however, when with slinking evasion, good conduct has been violated and punishment lies in the offing. Thieving is followed by violent imprecations from the outraged natives, who follow offenders with a thrashing, or well-

Eskimo sledge dogs working over badly fissured and decomposed sea-ice during the last week of June in south-western Baffin Island.

directed sticks, stones, or other convenient missiles. Presently, in a widely-formed circle about camp, the culprits squat stolidly in abashed and idle curiosity to await developments and formulate future schemes. Under ordinary circumstances if the packs become too attentive and troublesome, it is only necessary to go through the motion of bending for a stone to make the animals slink off with hanging head and tail.

Barring exceptional circumstances, the Baffin Island dogs are permitted to roam at large. Newly-acquired dogs, however, are ordinarily tied up for a few days until accustomed to altered surroundings, and fellow workers. Some with a marked propensity for wandering are retarded in their movements with a forefoot tied up, or stick of wood suspended from the neck. As a rule, while travelling, dogs have their freedom about the igloos the same as at the settlement. Once in a while exceptional individuals inspired by craft, or homesickness, desert the first night out and return home. Dogs known to have a habitual failing of this kind are tethered at night until the party is 50 to 100 miles away, after which desertion rarely occurs.

The endurance of the Eskimo dog is literally astounding. This capacity has inspired the unqualified admiration of every man who has witnessed the animal in action over prolonged and difficult periods in mid-winter. In hardiness it undoubtedly surpasses all other domestic animals, including the reindeer. The lowest temperatures are endured with ease, and sleep habitually indulged without shelter of any description. In the severest cold of mid-winter, individuals contentedly curl up for the night in the most exposed places with apparent indifference. Usually, however, during the progress of violent blizzards with high winds and fine, drifting snow, some effort is made to find shelter in the lea of igloos, discarded snow-blocks, or other objects.

Starvation is withstood with marvellously protracted endurance; instances have been recorded of dog-teams that have worked hard under severe conditions, with reduced rations as well as absolutely foodless days, running into a period of several weeks. During the writer's exploration of the west coast of Baffin Island in the winter of 1929, the dogs were subjected to 35 days of almost continuous travel over a distance of about 900 miles; winds and temperatures were severe, the dogs subsisted entirely on frozen seal and walrus meat—a substantial portion of the period on unavoidably reduced rations and the last two days without food of any kind—yet arrived again at head-quarters with apparently the same vigour with which they left.

The Eskimo dogs of Baffin Island live chiefly on seal, walrus, and white whale meat procured by the native hunters. Kind, quantity, and quality of food depend to a large degree upon locality. In some places, such as at Nuwata, the dogs live chiefly on walrus meat procured in late summer and stored for winter use in stone caches; in the Pangnirtung region much white whale meat is fed, some of which is preserved in vats in its own oil; in numerous places neither of these animals are obtainable and the dogs are fed principally on seal meat. In some cases this meat is stored in advance in stone caches; again, it is obtained fresh at regular intervals and fed as required.

These dogs, as a matter of fact, will eat almost any kind of meat, fresh, or decomposed; their appetite is perfect, free from fussiness or discrimination. Fish are taken either fresh, or frozen raw, but little of this is fed to the dogs in the Eastern Canadian Arctic. Here the dogs are meat-eaters first and foremost. To the writer it would appear strange to witness these animals eat anything else. He has frequently tried them with bread, biscuits, potatoes, etc., out of curiosity, to see one and all consistently ignored.

The usual Eskimo dog ration in winter travel is about 2½ to 3 pounds of frozen seal or walrus meat a day. They are fed but once — always at night, with the day's work completed. Under stress of food shortage for relatively short periods, half the above amount will suffice, or the animals may be fed a normal ration every other night. The remarkable pluck and tenacity of these creatures, on native meats, permits them to go for days without feeding, sacrificing little or no vigour in the

A typical black and white "husky" harnessed ready for the trail. Courtesy Hudson's Bay Company

A group of Eskimo sledge dogs in Foxe Peninsula, south-western Baffin Island. This illustration depicts the nature of the harness; the single trace pulls from the V-tip of the harness at the posterior part of the back; the two side units of the harness are joined across the chest and the nape of the neck.

Eskimo sledge dogs of the Lake Harbour region, Baffin Island.

effort. It may be mentioned, in the matter of feeding, that a little ill-luck may overtake any Arctic party, when feed or no feed, the resolute grind must continue. On the above diet Eskimo dogs maintain their health well in the coldest weather and for journeys of unremitting labour up to at least 1,000 miles in length.

During the winter the Eskimos are very thoughtful of their dogs' welfare and feed with as punctilious regularity as circumstances permit. They are frequently fed on the warm flesh of freshly-killed seals at the floe-edge, which is advantageous, otherwise they subsist on frozen meat. Summer treatment is radically different; in some respects it is the most trying time for dogs, what with heat, flies and mosquitoes, and the necessity of shifting for themselves. At this time no consistent effort is made to maintain them, though usually they secure small, irregular quantities of offal and refuse about the settlements. The animals, therefore, singly or in bands, forage widely over the country in search of food. Inland, lemmings and young birds undoubtedly contribute at this time. But they more consistently adhere to the sea-coast in search of shrimps, sculpins, mussels, and any cast up organic matter normally to be secured at low tide. Between camps and suitable feeding grounds, the bands often travel daily with unfailing regularity. Conspicuous paths are thus worn during these summer activities along the coast, which from a little distance appear as game trails.

In hard times dogs will ravenously consume almost anything of animal origin available. As a result they are excellent hygenic agents in "mopping up" about Eskimo dwellings. It is said, however, that those animals, though not averse to eating fox meat, or even one another under stress, will not touch wolf flesh or polar bear liver at any time; the latter is reputed to cause violent sickness. With Eskimo dogs about, skin lines, harness, skin clothing, and kayaks must be carefully guarded.

The notorious thieving propensities of the breed are well known. Caches of meat must be well weighed down with rocks; *tupiks* are never left without barricading

Eskimo sledge dogs in the vicinity of a snowhouse at Lake Harbour, Baffin Island.

the small, wooden doors with boulders. The cunning displayed is almost incredible as they filch at every opportunity. Edibles are spirited from *tupiks* practically under the very noses of the occupants; with a slackening of precaution, skin bedding is devoured, and dried fish pilfered from slack, overhanging lines; in the depth of night they may insinuate themselves into ordinary tents with silently flawless technique to make off with anything that is eatable. Articles not gulped forthwith are as likely as not to be defiled. One of the worst calamities that can befall an Eskimo is for a pack of dogs to devour the *ugjuk* skin covering of his kayak that may blow from its high perch during a night gale. Security of paraphernalia is maintained at the price of eternal vigilance. Because of this, white men seldom, if ever, take dogs along while summer travelling by stream or sea; but unless camped on an island, the usual precautions are observed, as strays may appear anywhere along the Arctic Coasts.

The sledge dogs of Baffin Island and elsewhere suffer periodically from a disease somewhat similar to distemper, or the "fox encephatitis" found on silver fox farms of more southern latitudes. So far as the writer knows, the exact nature of the sledge dog disease has not been finally determined. In its more virulent form the death rate is high, the epizootics being very contagious, susceptible to spread from district to district, and normally transferable through the agency of infected dog-teams. In some instances the majority of dogs perish in many communities. The periodic epidemics appear to be similar to those among Arctic white foxes, and also associated with cyclic abundance of that animal. The disease is indicated in dogs by erratic behaviour, and foaming at the mouth; peculiar locomotion develops leading to greater and greater weakness until death ensues. The whole problem has an extremely important bearing upon the economic life and welfare of the Eskimos, as well as upon the efficiency and safety of white travellers residing in the Arctic regions.

An account of the Eskimo dog would lack somewhat without a little detailed reference to his mode of usefulness—the only real justification of his existence—in which intelligence and disposition are

strongly portrayed. Baffin Island and other Eskimos hitch their dogs in the style known as the "fan". Each dog has an individual trace attached to the bridle of the sledge and is consequently free to assume an independent position in the team. The trace of each animal varies in length in relation to the others; this arrangement prevents "bunching" while proceeding through narrow defiles, or rough, rafted ice at sea. The lead dog, the most intelligent and best trained animal of the team, possesses the longest trace, which may be upwards of 25 to 30 feet in length.

For open country travelling on the wind-packed snow characteristic of the Arctic, this style of hitching is, in the writer's estimation, superior to all others. The most obvious advantage arises from the ability of the dogs to spread out and individually select the best footing on broken ground, difficult grades, and for wide distribution of team weight on treacherous ice. In bear hunting there is also the advantage that the dogs may be rapidly cut adrift, each to attain individual freedom, and therefore greater safety is achieved with more speed and efficiency than by any other method.

Every style of driving, however, has its imperfections. One unavoidable though minor drawback to the fan hitch arises from the inclination of the animals to intermittently shift places; this results in the braiding of the numerous traces forward of the toggle, with the necessity for "clearing" after every few hours of travel. If ignored, the braid increases in length to the point where the rear dogs are badly hampered. There would also appear by this method of hitching to be some loss in pulling power; nevertheless, this style enables a good Eskimo dog to pull upwards of 150 pounds, or between one and one-half times and double his own weight on occasion, so that any loss in hauling ability through the fan hitch is not very serious.

All movements of the team are governed by the use of the whip and vocal directions of the Eskimo driver. An alert leader promptly responds to these and the rest of the team swings in unison. The voice of a strange driver usually throws a team into confusion, and if it be a white man lacking the familiar gutterals of the Eskimo, the outcome may have ludicrous and laughable, if not exasperating, results. Some time is required for a white man to acquire the art. Much of the driver's authority is brought to bear with a long whip 20 to 30 feet in length. Such persuasion is very effective when the voice fails to achieve proper and prompt response. So skilled is the Eskimo in the use of the whip that he can, with neat discrimination, touch up any dog in the team, but it is seldom wielded with temper or malice. However, the dogs know how to disobey and at times are seized with devilish perversity, when the whip may be wielded with cruel effect.

A team varies from a few animals up to 10 or 12 in number, depending upon circumstances. A solitary hunter with a light sledge, making the usual daily rounds to "sealing holes" and floe-edge, seldom requires more than five or six dogs. In good game districts a tendency exists to maintain larger teams, but where meat is scarce there is sure to be a reduction in the number of mouths to feed. An explorer with heavy haulage on long journeys will usually require units of from 12 to 16 selected dogs. Such teams are easily capable of hauling loads of 1,000 to 1,200 pounds, for an average distance of 25 to 30 miles daily on hard snow. Under pressure, with a lighter load, a team of good dogs can travel up to 50, 60, or even 70 miles in one day, but this cannot be maintained for any great length of time.

Not only does the Eskimo dog fall heir to harness and haulage on the seven or eight months of winter trails, but he is also occasionally used as a beast of burden in summer. For packing, a primitive sort of pack-saddle is made from seal skin, or canvas, in which the load is suspended. Strong dogs will carry loads nearly half their own weight. This mode of travel is adopted by the Eskimos on long interior treks after caribou for ground robes and winter clothing. On such hunts man and beast depend for food upon the results of the chase, which may last from a few weeks to several months.

EDITOR'S NOTE-BOOK

Weston Gaul is a native of Nova Scotia where he received his education at St. Francis Xavier University. His experience as a journalist for many years in the port city of Halifax is reflected in his sympathetic treatment of "Canada's Shipbuilding Industry".

B. R. MacKay, B.Sc. (Mining, Queen's University), Ph.D. (Geology, University of Chicago), is senior coal geologist of the Geological Survey of Canada, which he joined in 1910. His intimate knowledge of the geology of the National Park regions of the Selkirks and Rockies has been acquired over a period of twenty years and more of topographical, geological and structural mapping and field investigations in central and southern British Columbia and in the Rocky Mountain coal-fields of Alberta extending from the International Boundary north 400 miles to beyond Smoky River.

Dr. MacKay is especially well qualified to appraise the geological complexity, scenic beauty and lure of the Rocky Mountains and Selkirks in comparison with those of other world-famous mountain ranges in that during the three years, 1920-23, he was engaged in geological explorations and mapping in the western Himalayas, Hindu Kush, Salt Range, Kashmir Native State, Punjab, North West Frontier Province and Burma. These expeditions carried him through the Khyber Pass and into many outlying areas of north-western India and northern Burma, seldom, if ever, penetrated previously by a white man. Dr. MacKay is President of the Ottawa Branch of the National Council of Education.

J. Dewey Soper, author of "Eskimo Dogs of the Canadian Arctic", published in this issue, is a native of Guelph, Ontario. After studying at the University of Alberta, he was appointed Naturalist to the Canadian Arctic Expedition of 1923 for the National Museum of Canada. Subsequently he spent several years in the Eastern Canadian Arctic specializing in zoological research and geographical exploration for the Dominion Government. Since 1934, Mr. Soper has been Chief Federal Migratory Bird Officer for the Prairie Provinces.